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(54) **IRRIGATION SPRINKLER NOZZLE**

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(58) **Field of Classification Search**

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(57) **ABSTRACT**

A nozzle for an irrigation sprinkler is provided, where the nozzle includes a sealing pad for reducing the distance relative to a seal of an irrigation device when the nozzle is in a retracted position to restrict the entry of grit and other debris into the irrigation device.

20 Claims, 28 Drawing Sheets

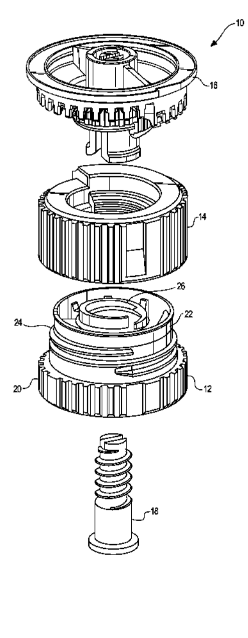

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Fig. 1

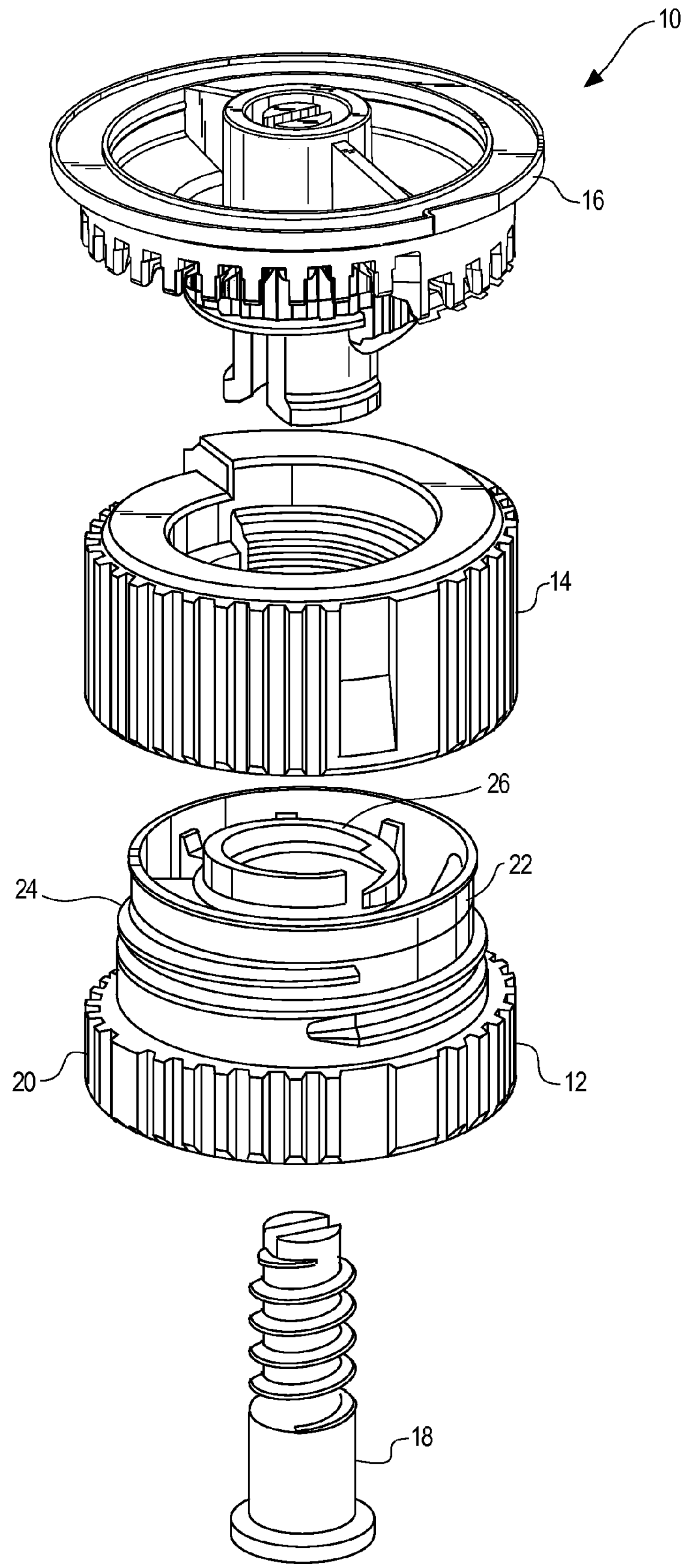


Fig. 2

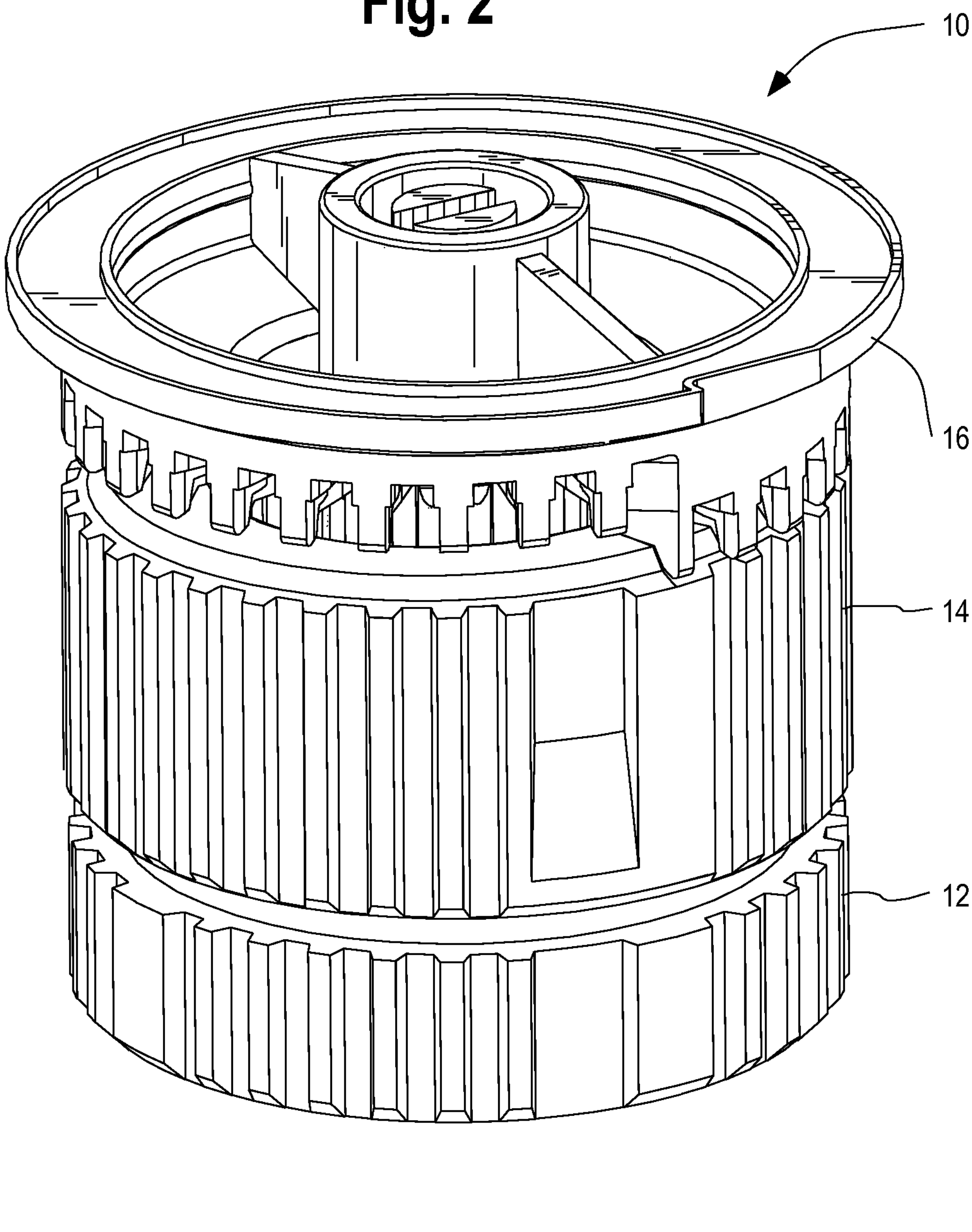


Fig. 3

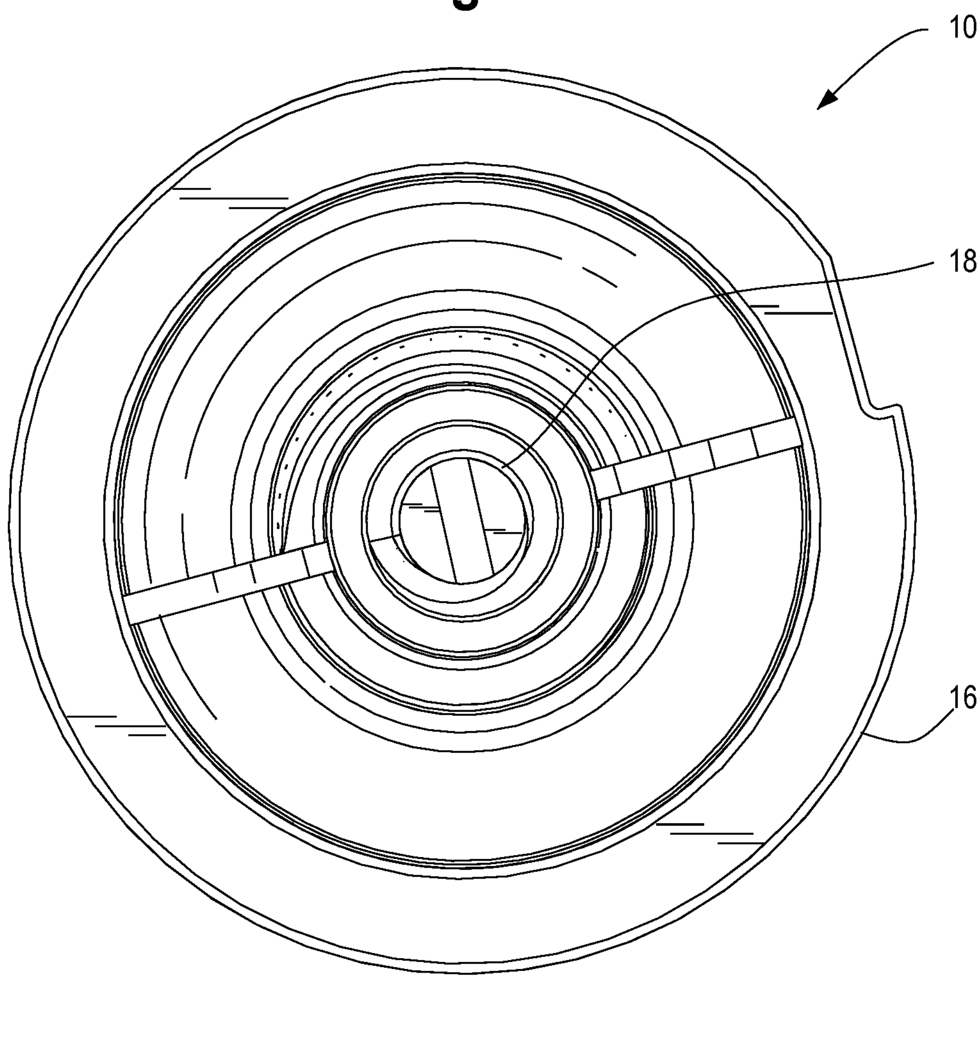


Fig. 4

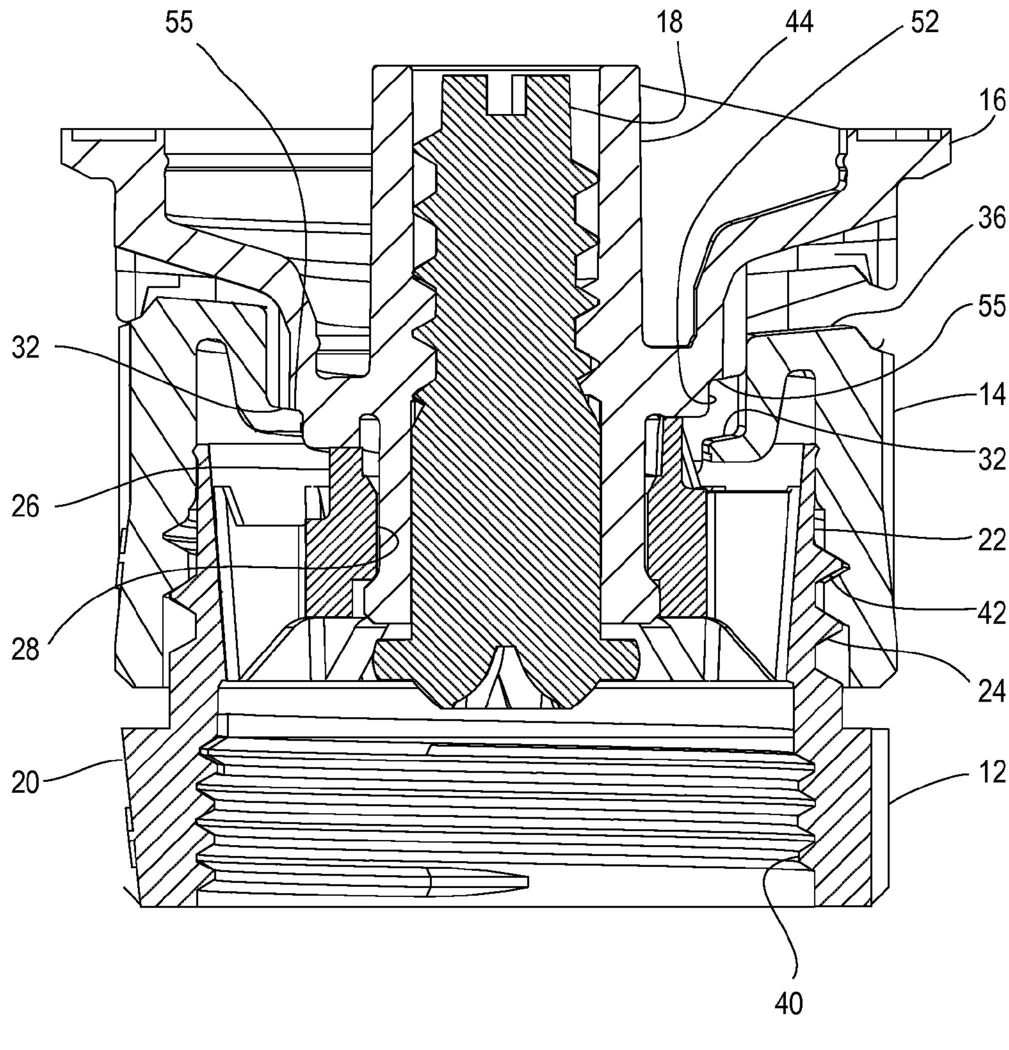


Fig. 5

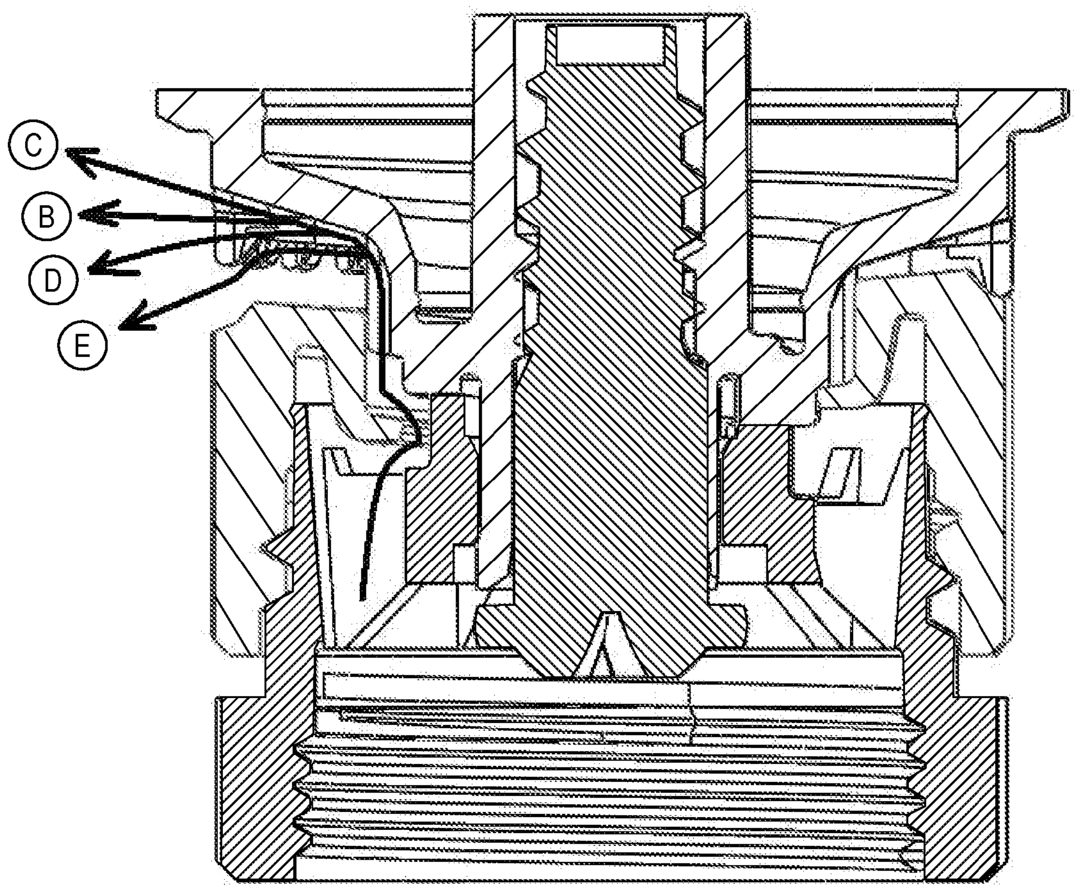


Fig. 6

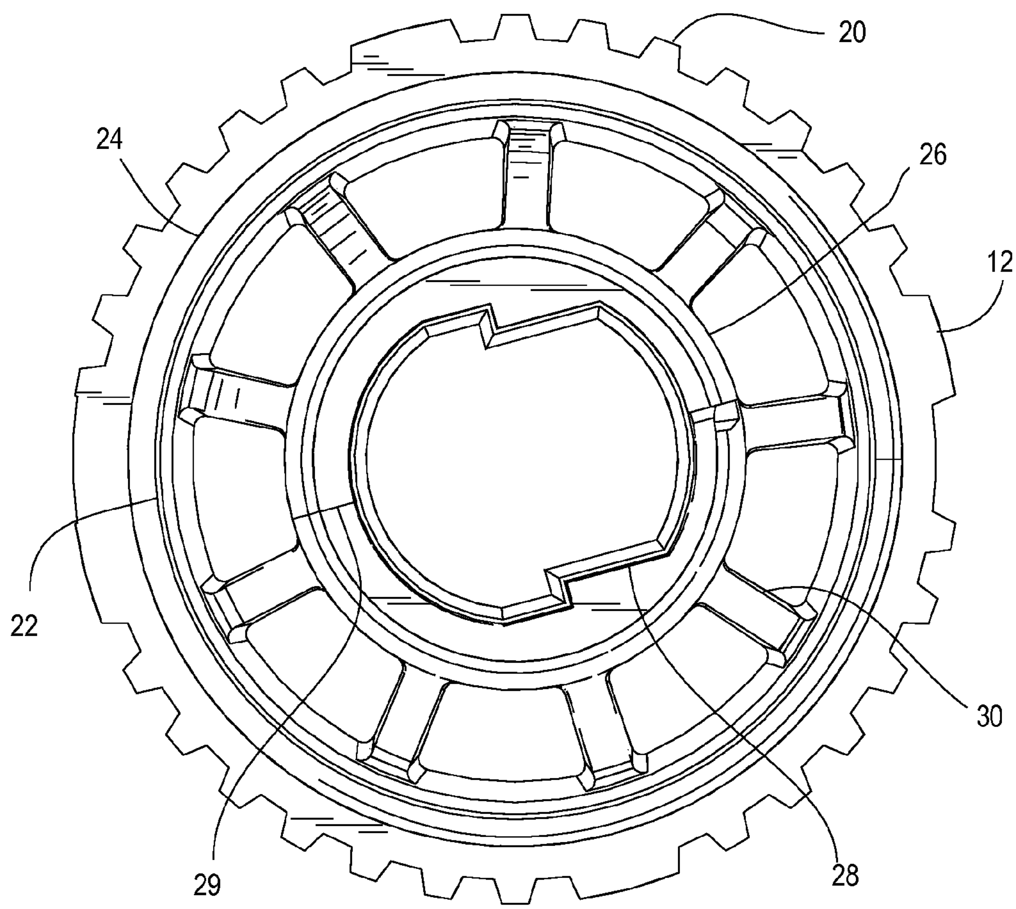


Fig. 7

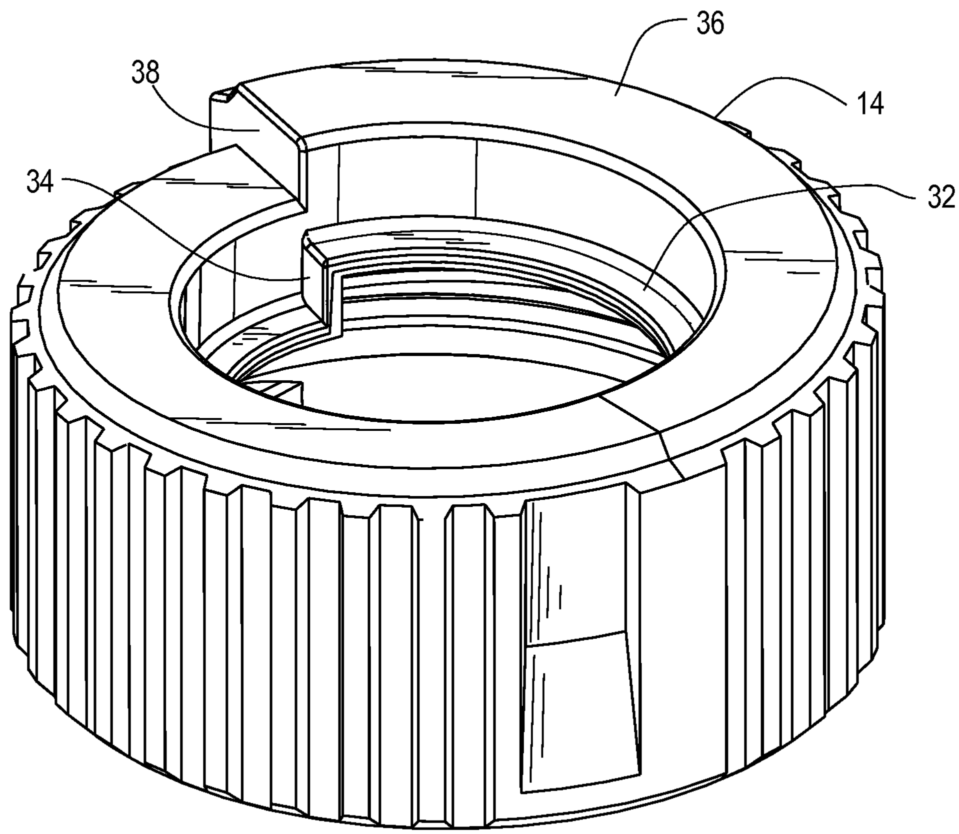


Fig. 8

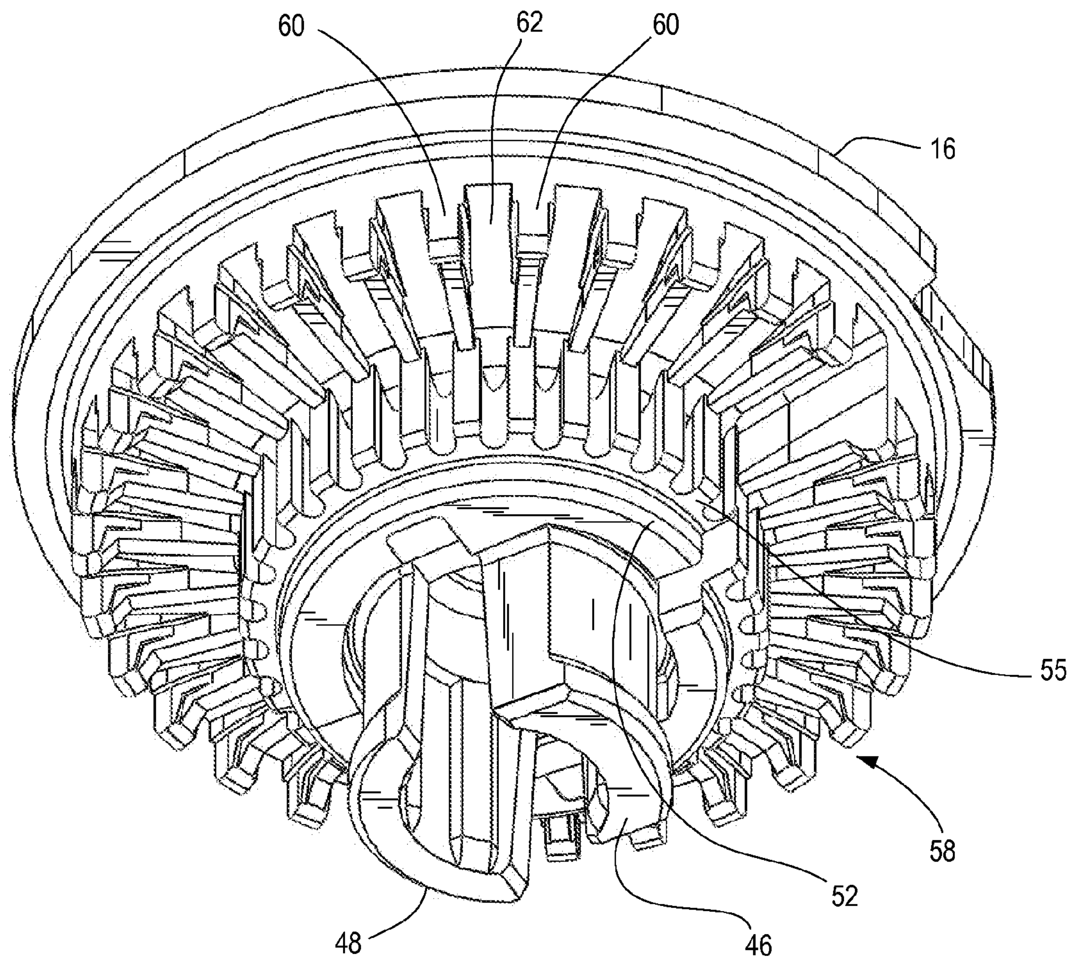


Fig. 9

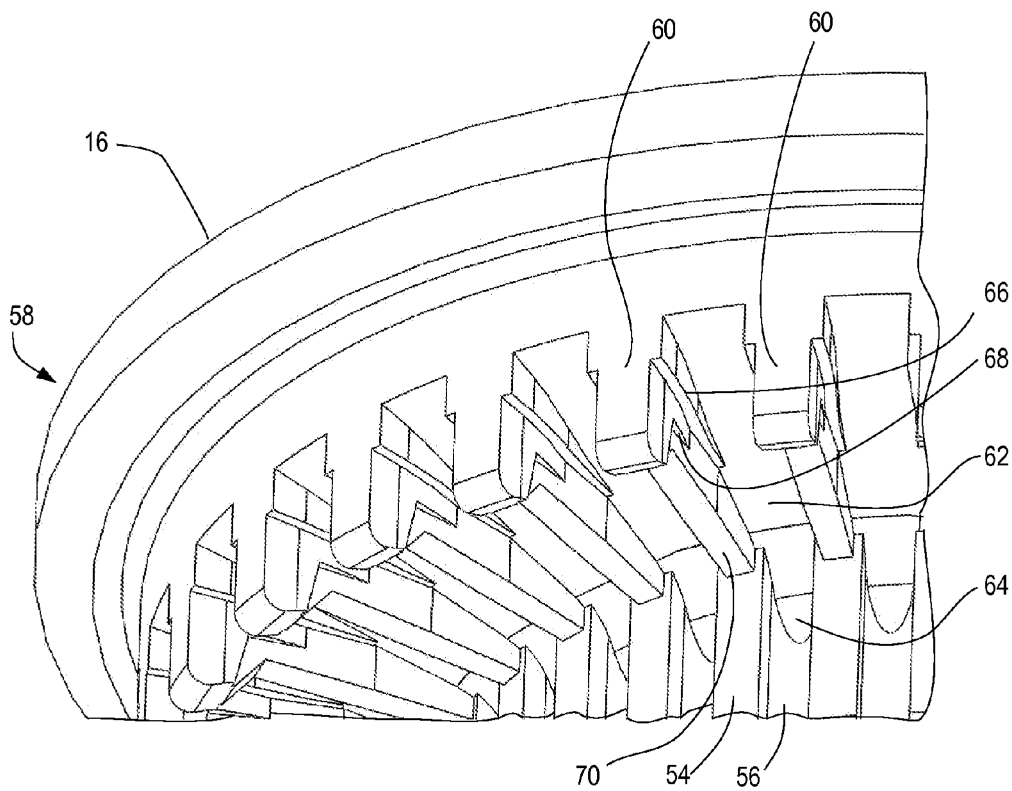


Fig. 10

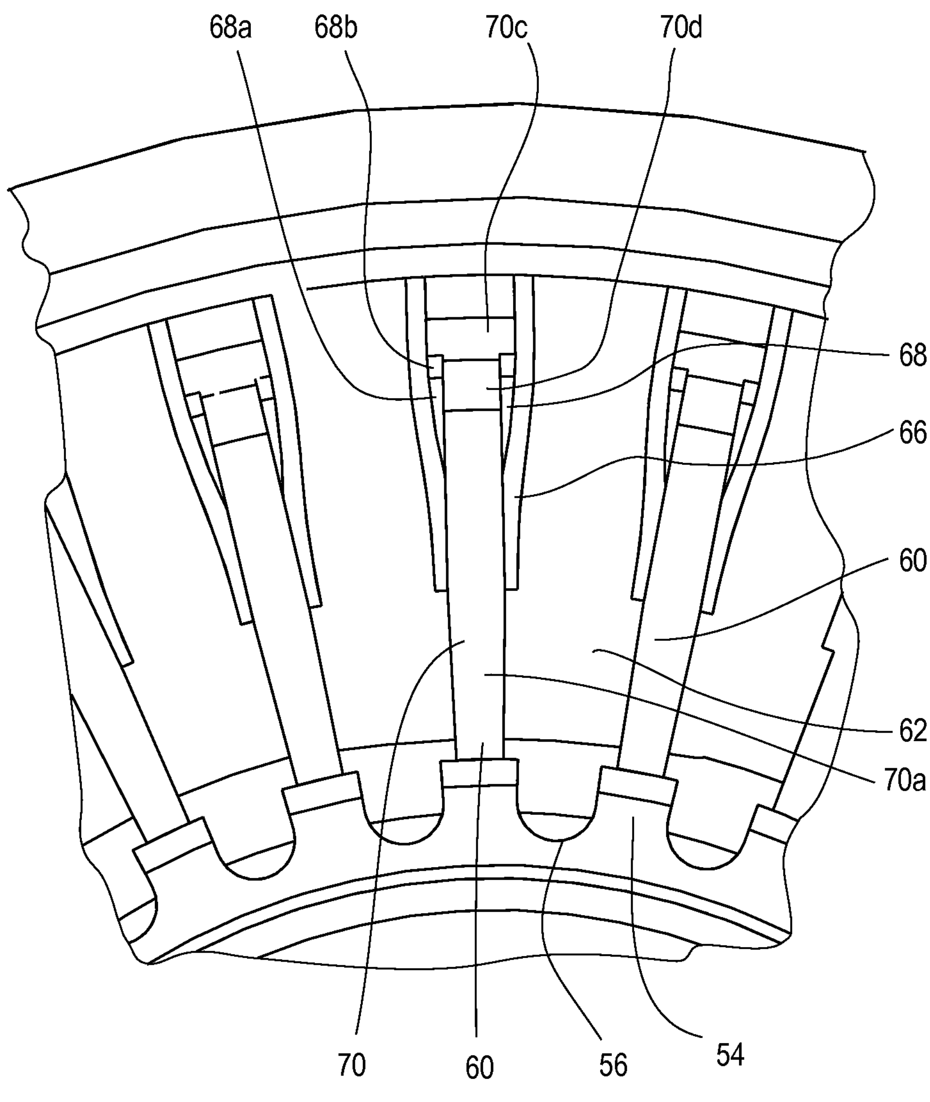
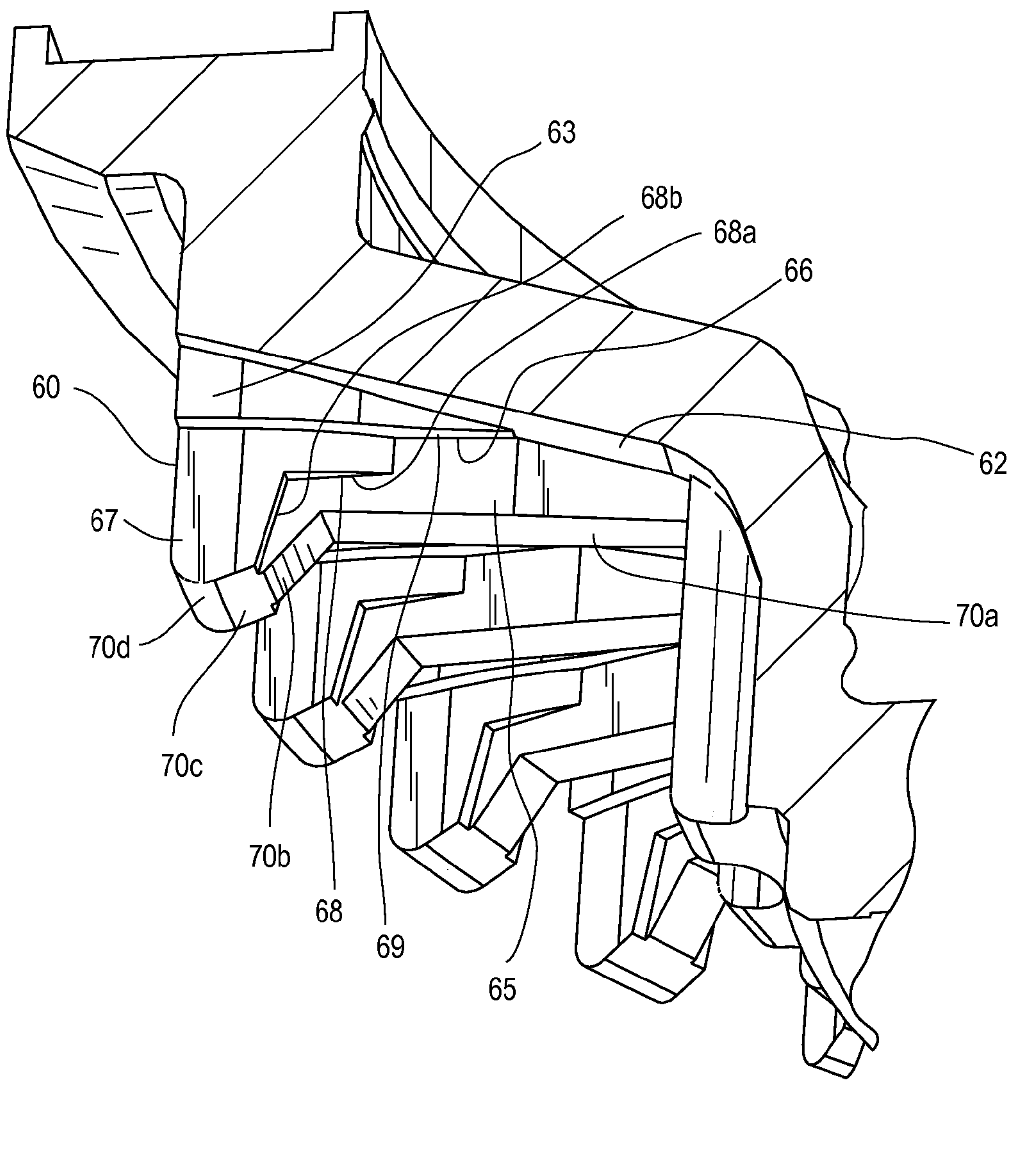


Fig. 11



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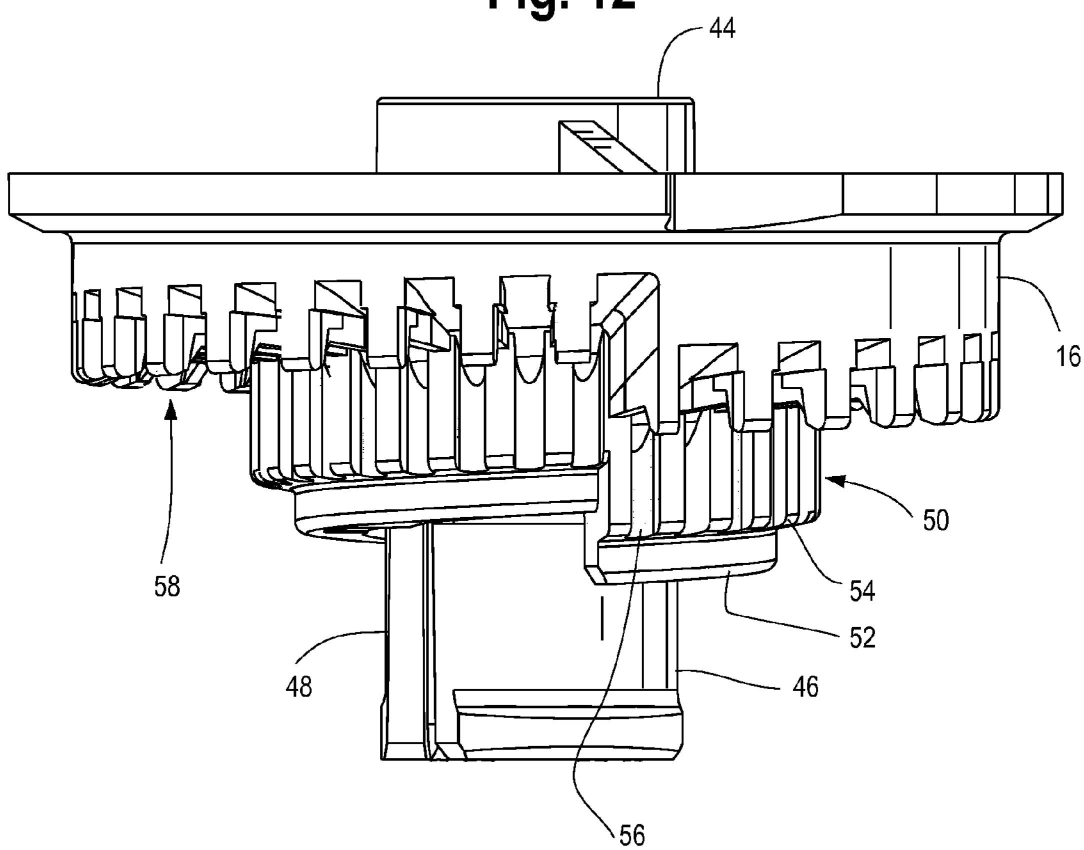


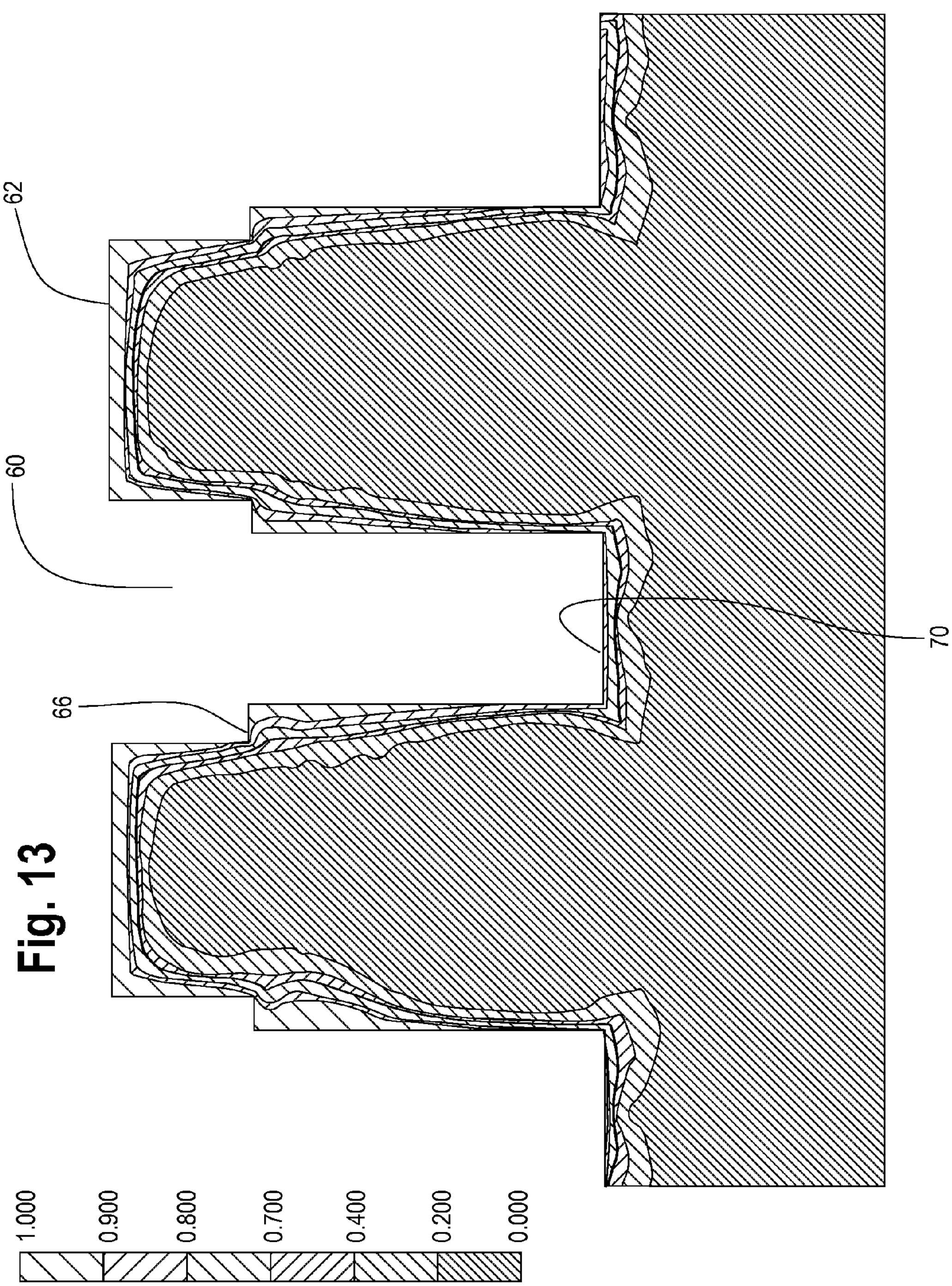


Fig. 13

Fig. 14

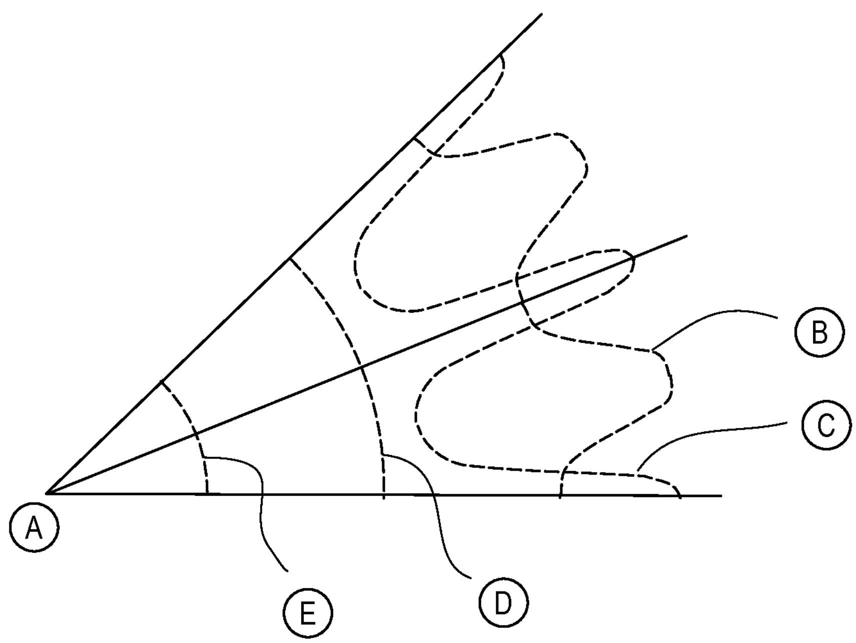


Fig. 15

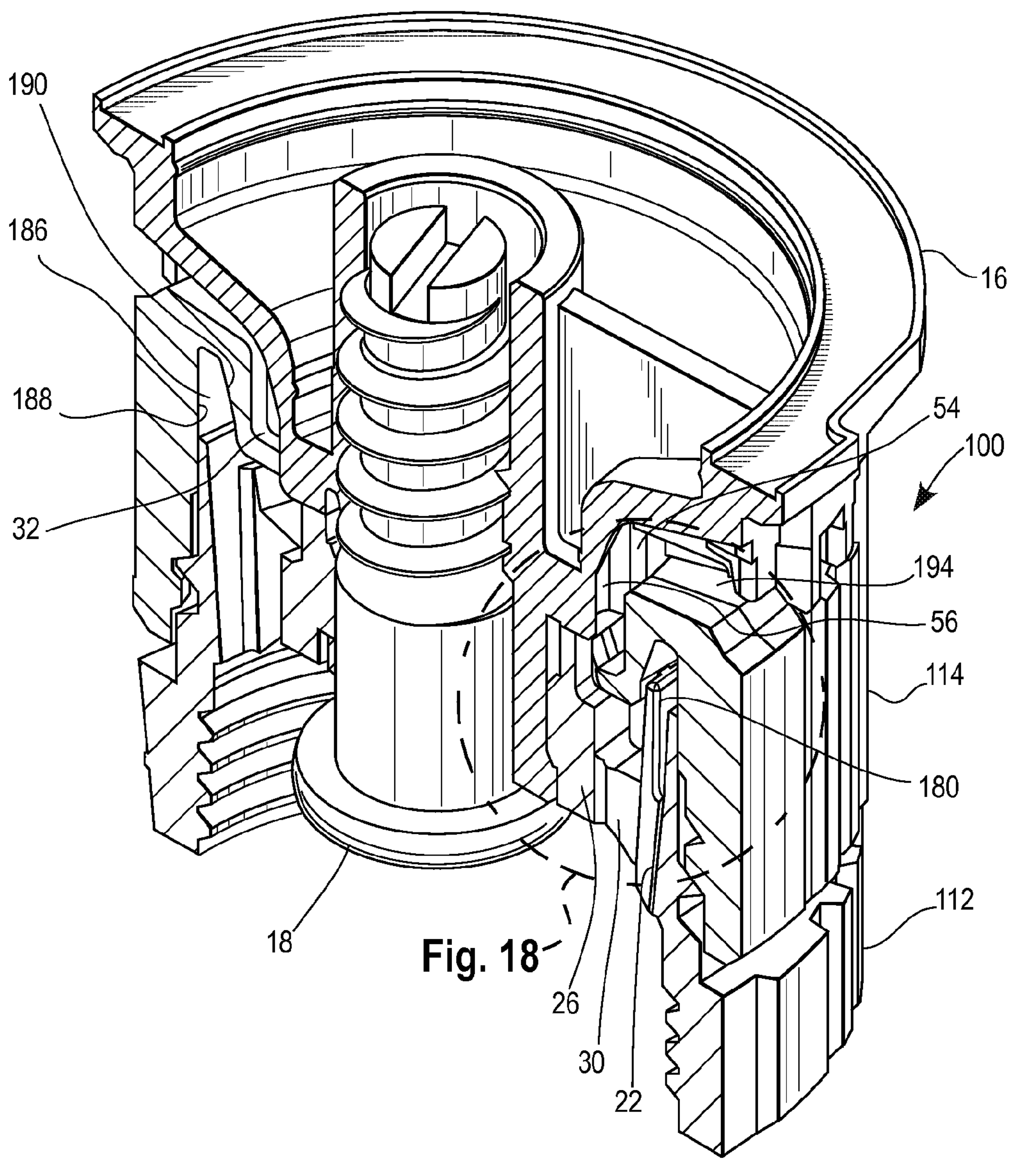
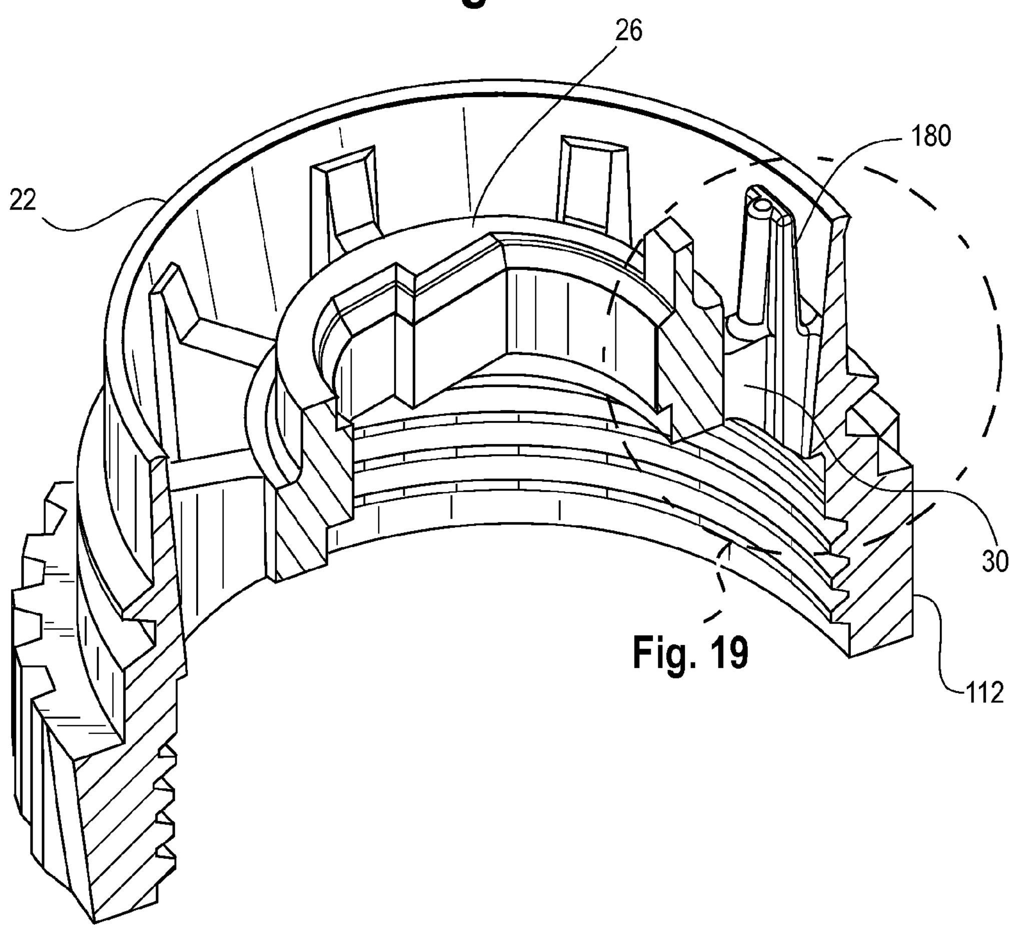


Fig. 16



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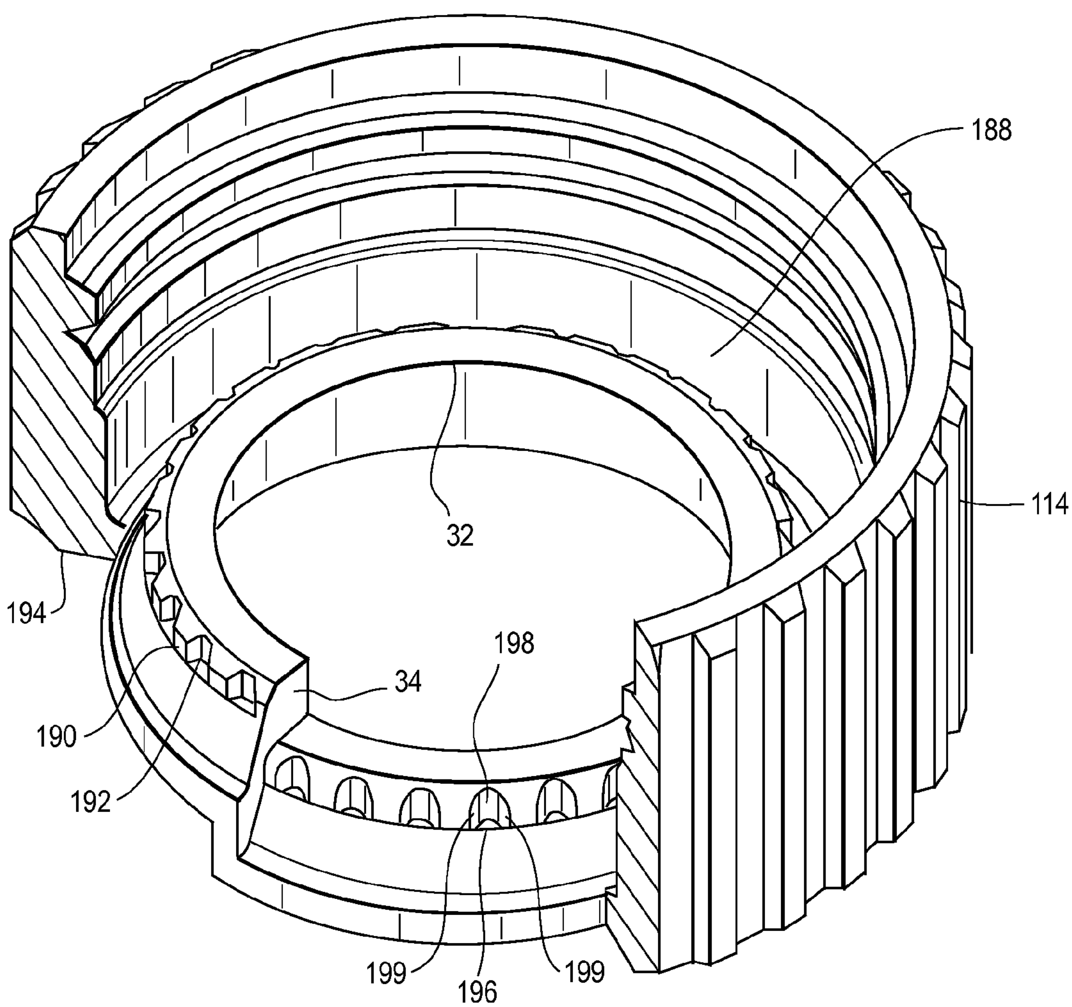

Fig. 18

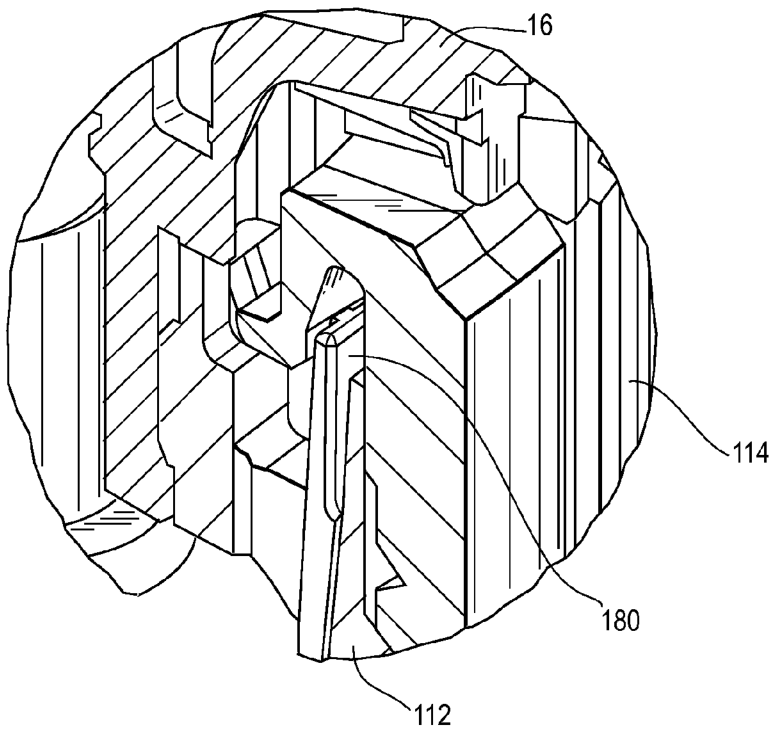

Fig. 19

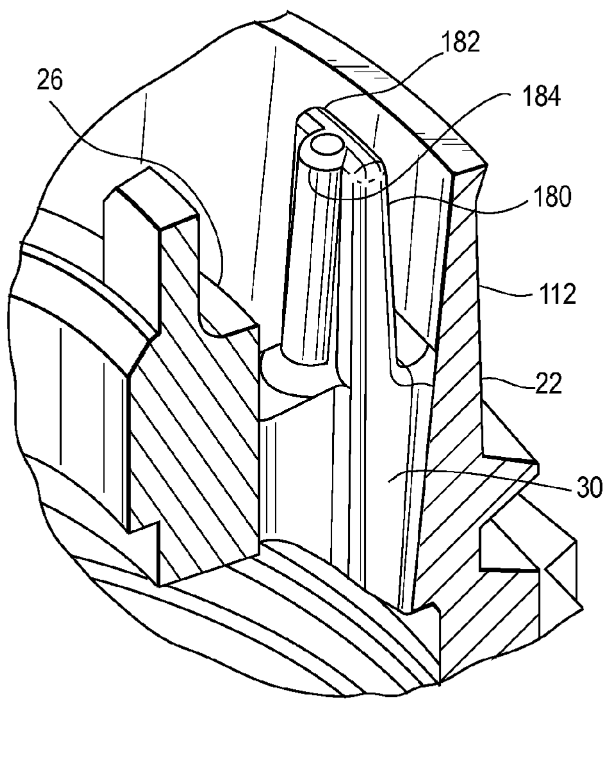

Fig. 20

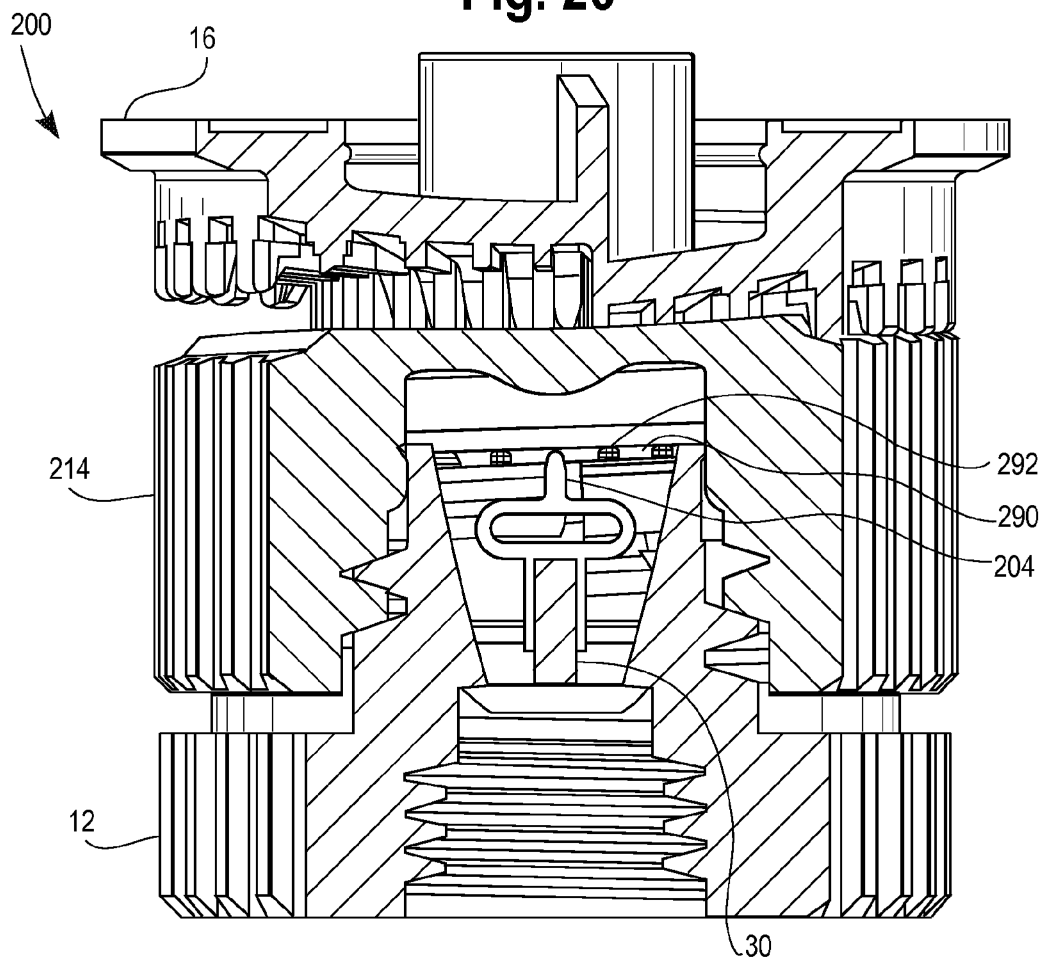

Fig. 21

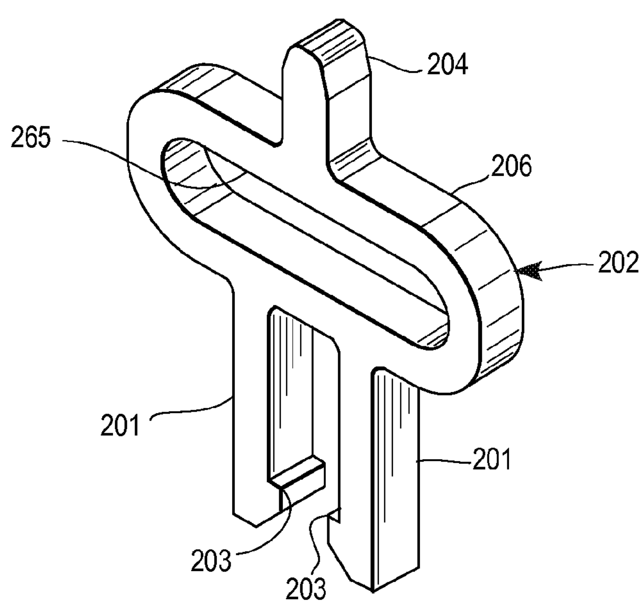

FIG. 22

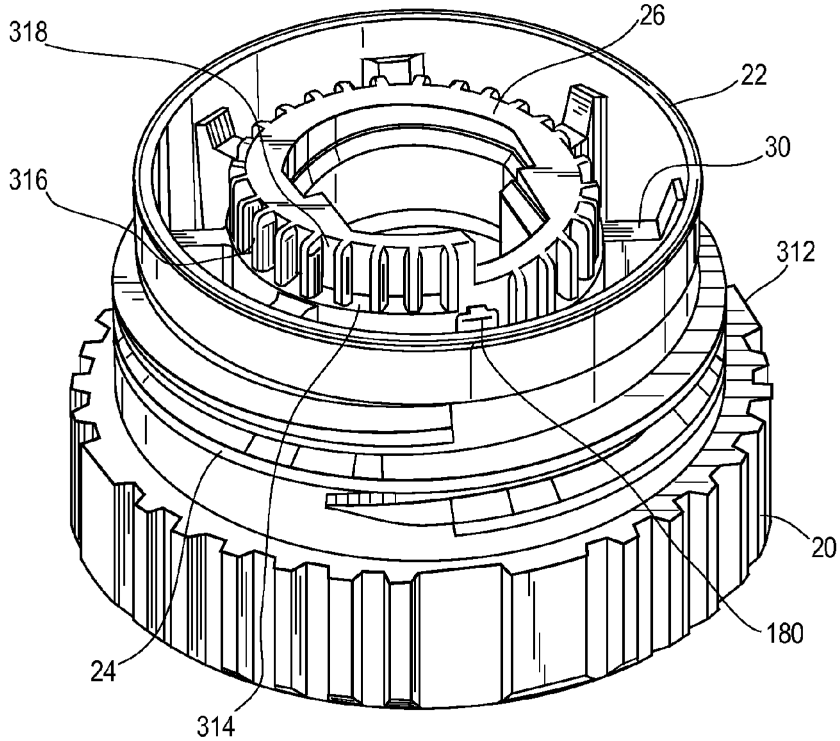

FIG. 23

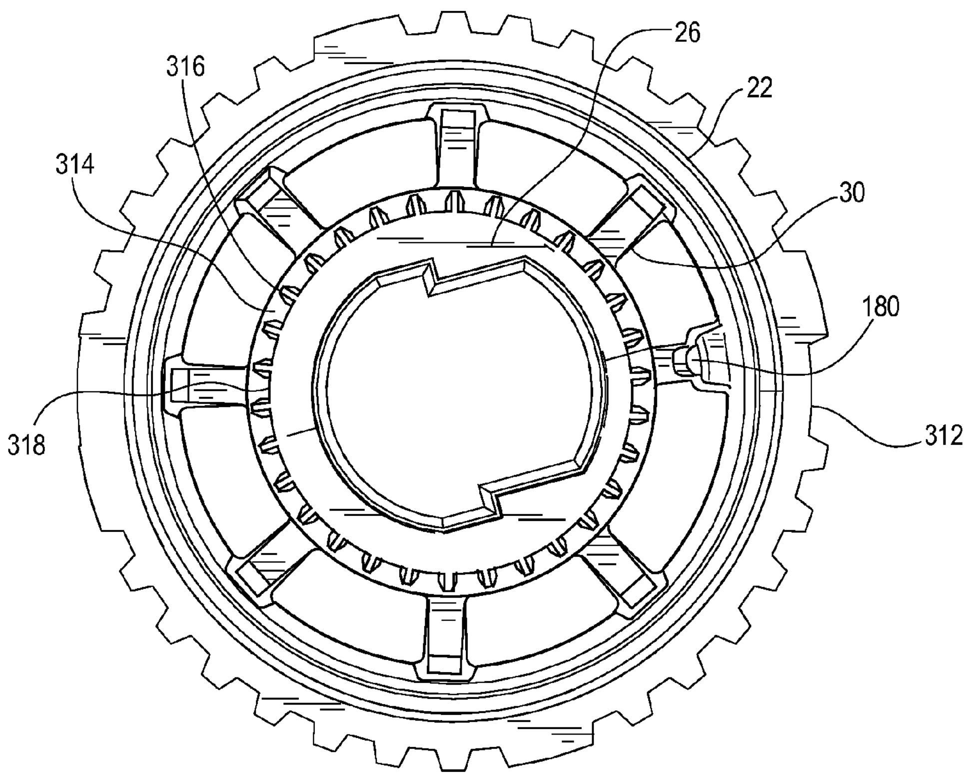

FIG. 24

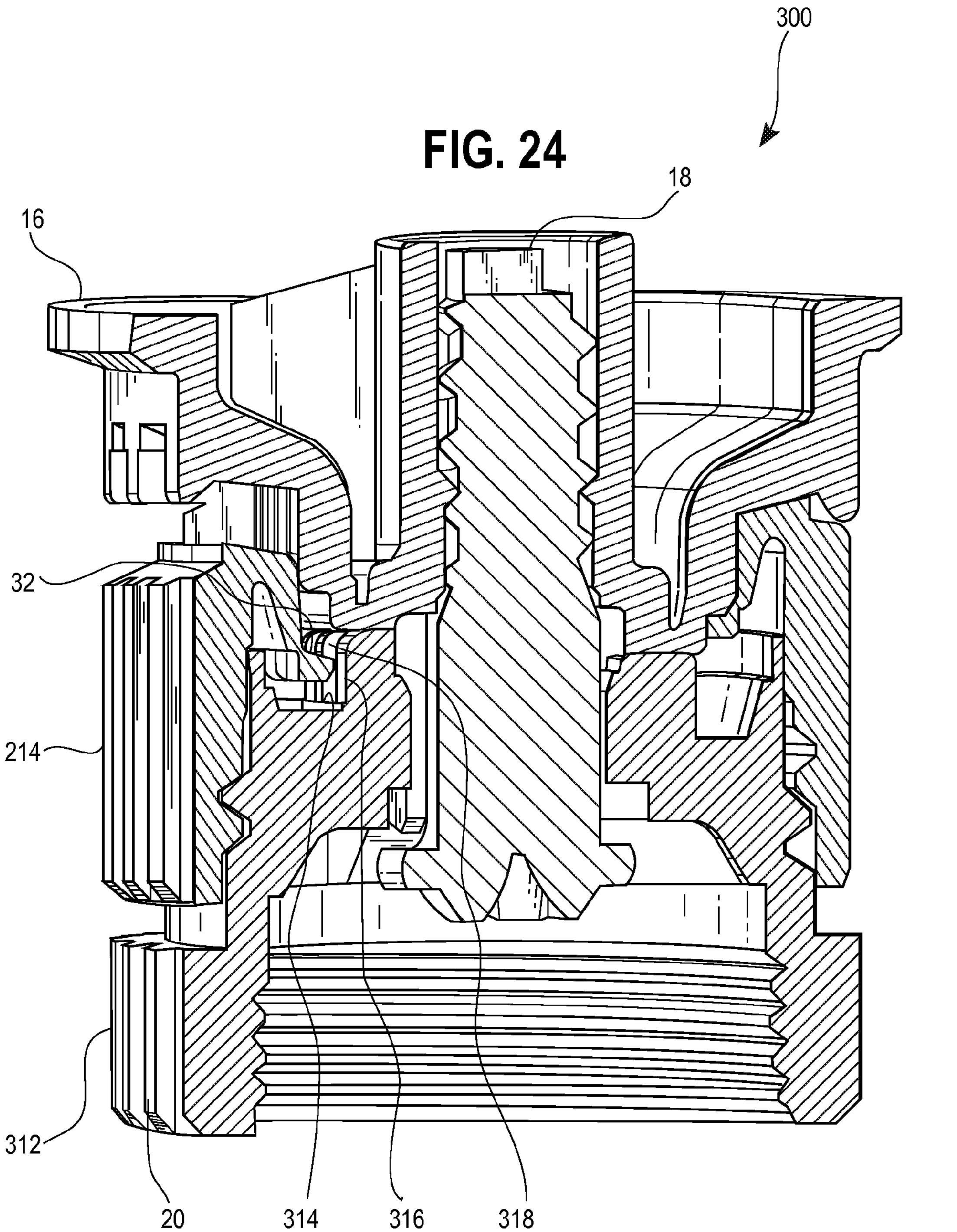

FIG. 25

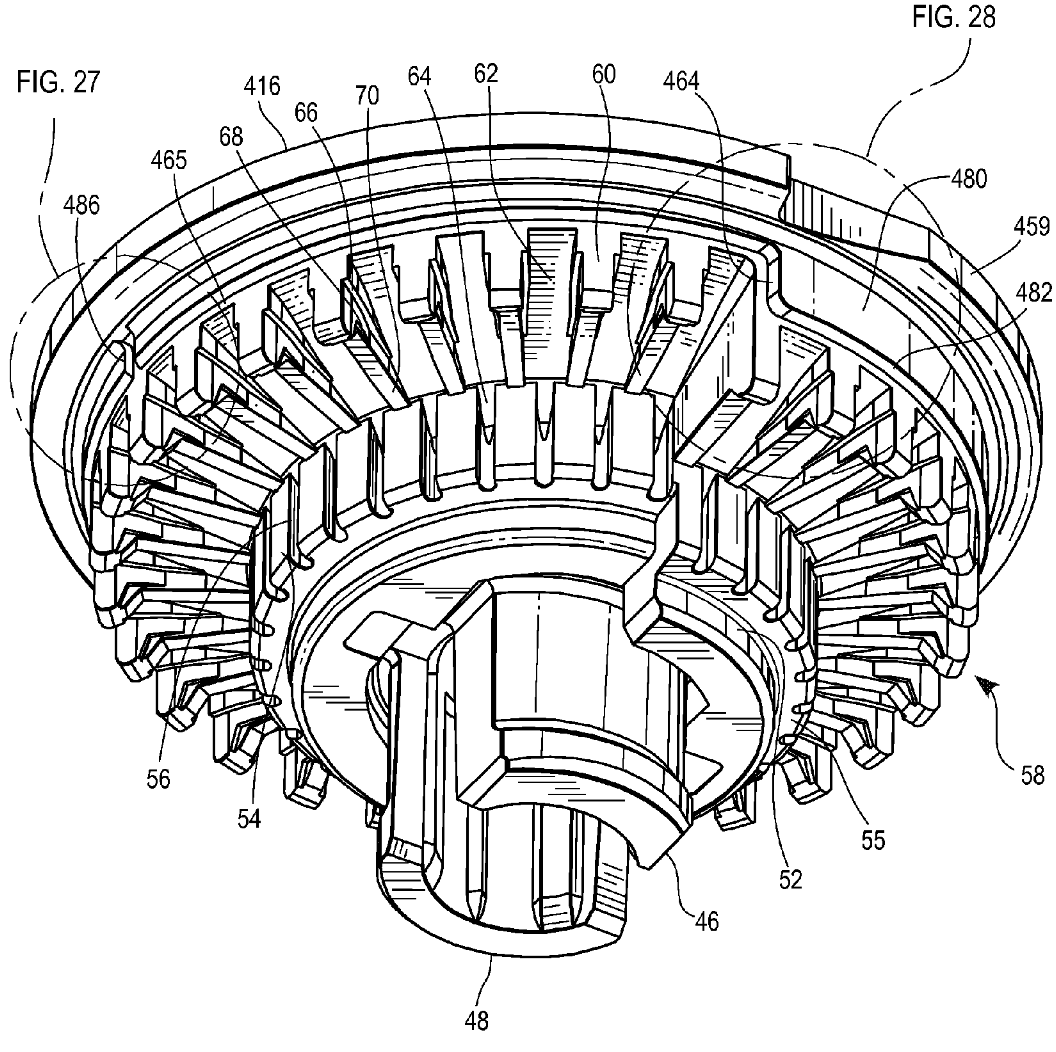

FIG. 28
FIG. 27
416
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FIG. 26

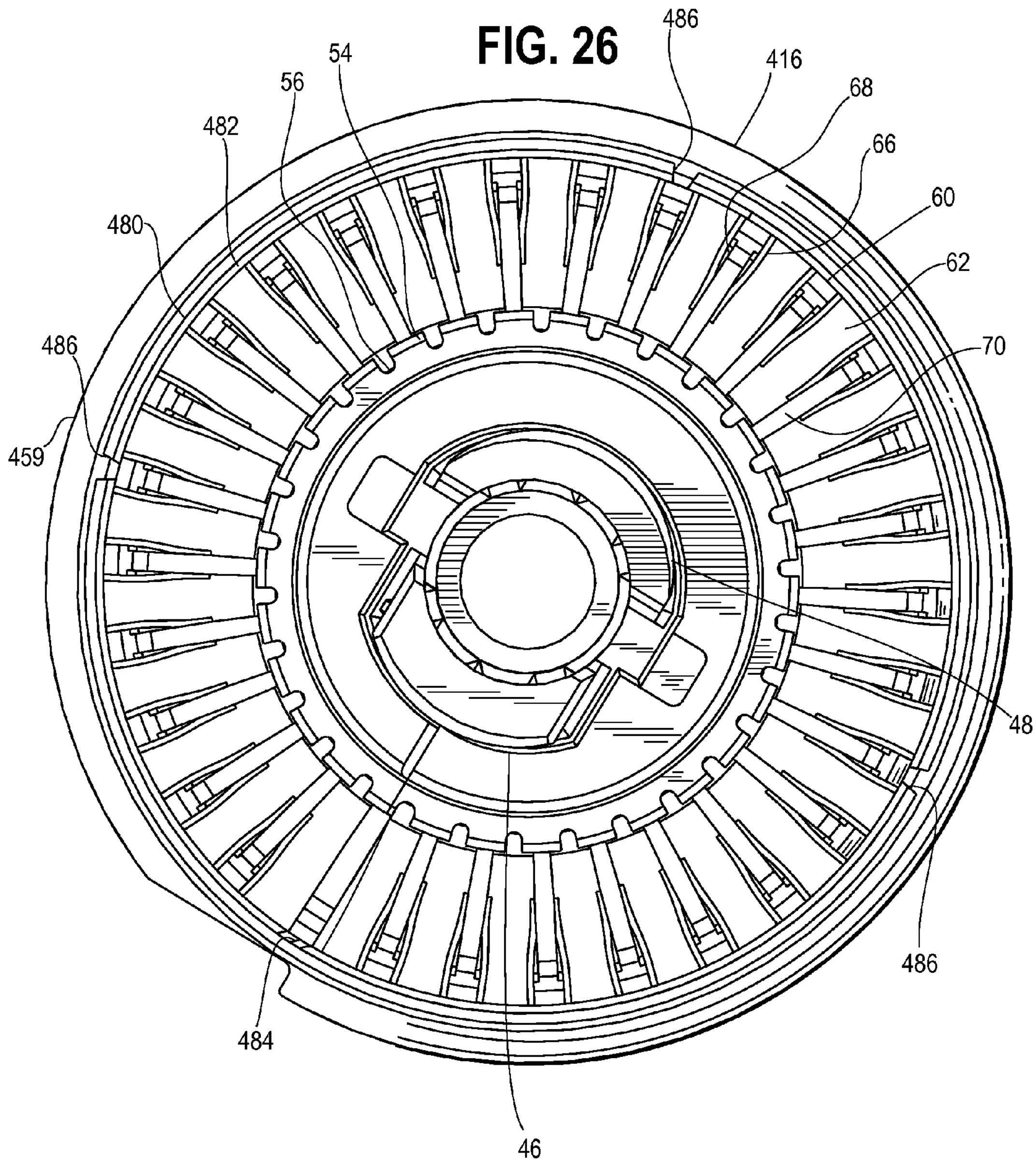

FIG. 27

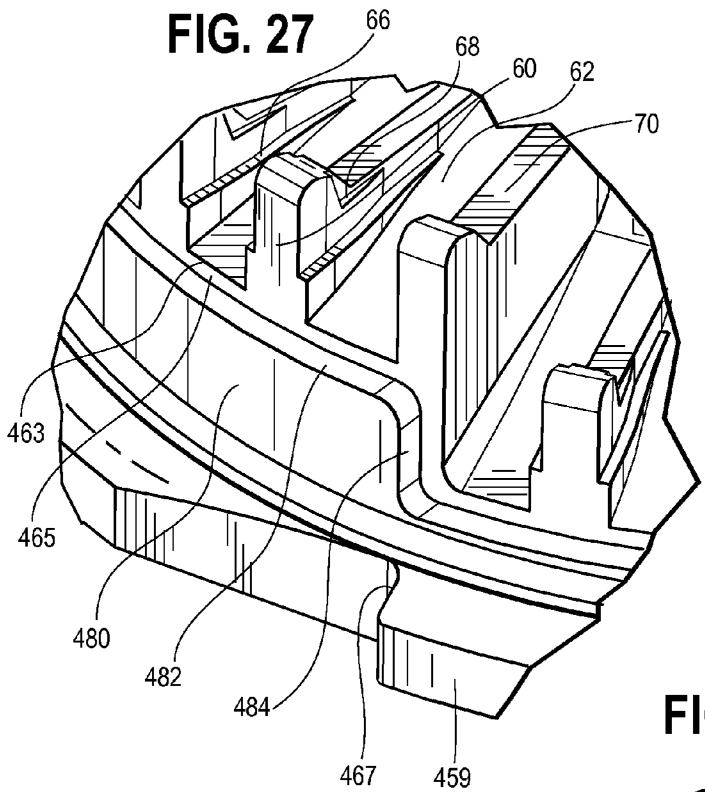

FIG. 28

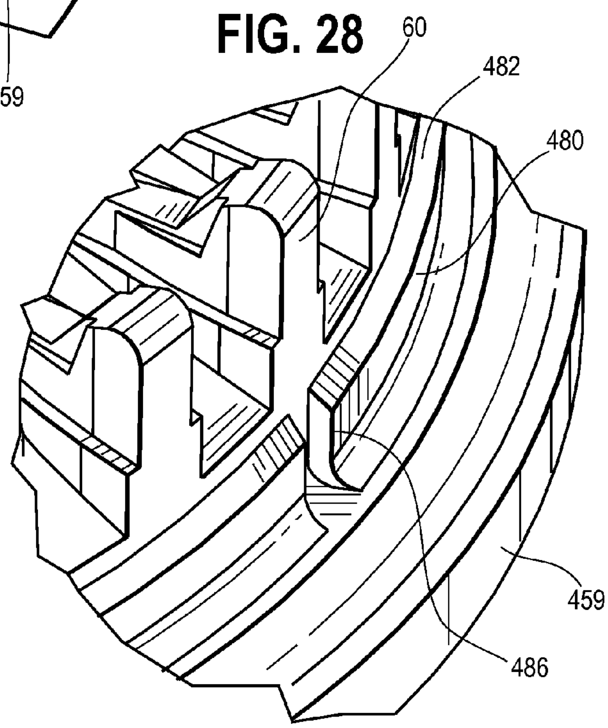

FIG. 29

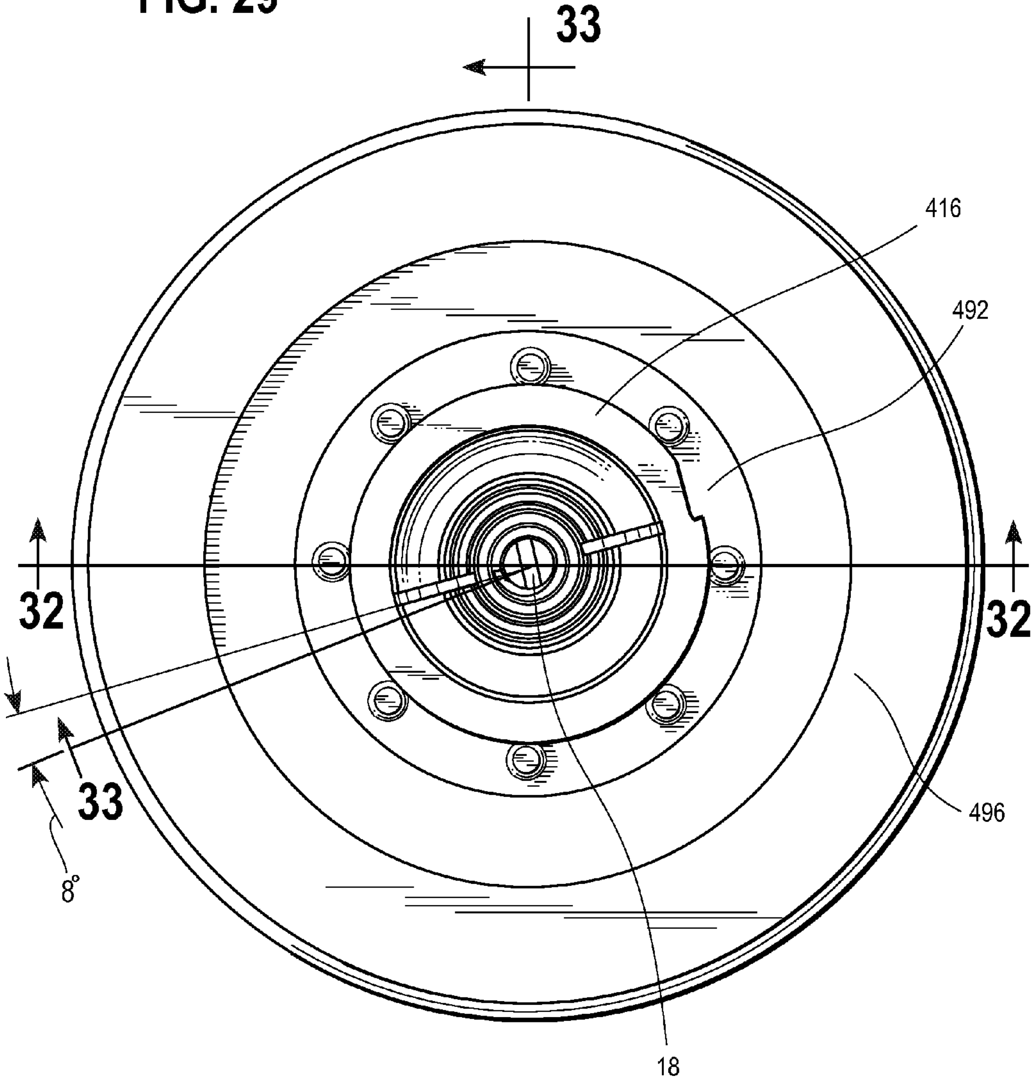

FIG. 30

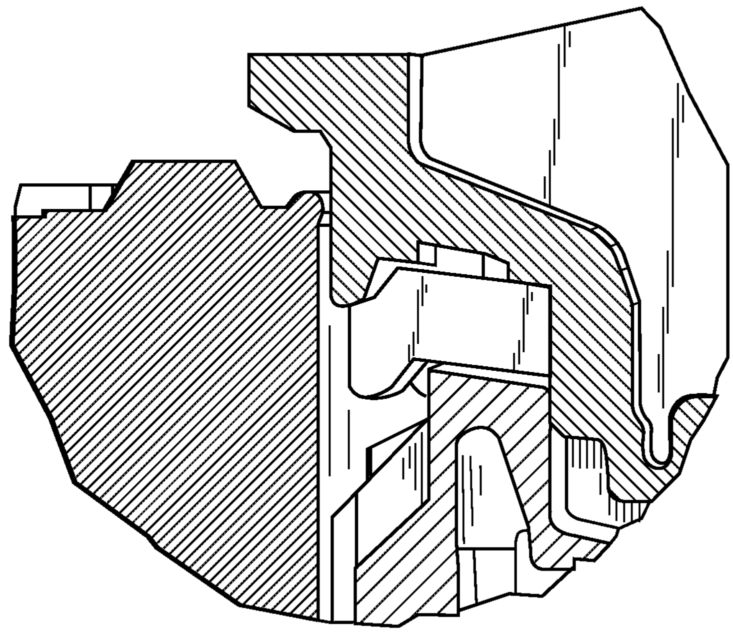

FIG. 31

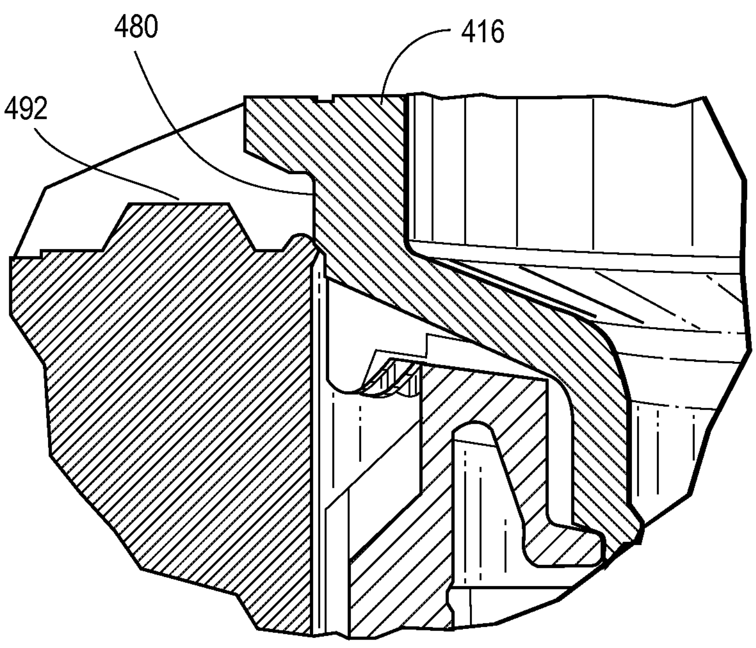

FIG. 32

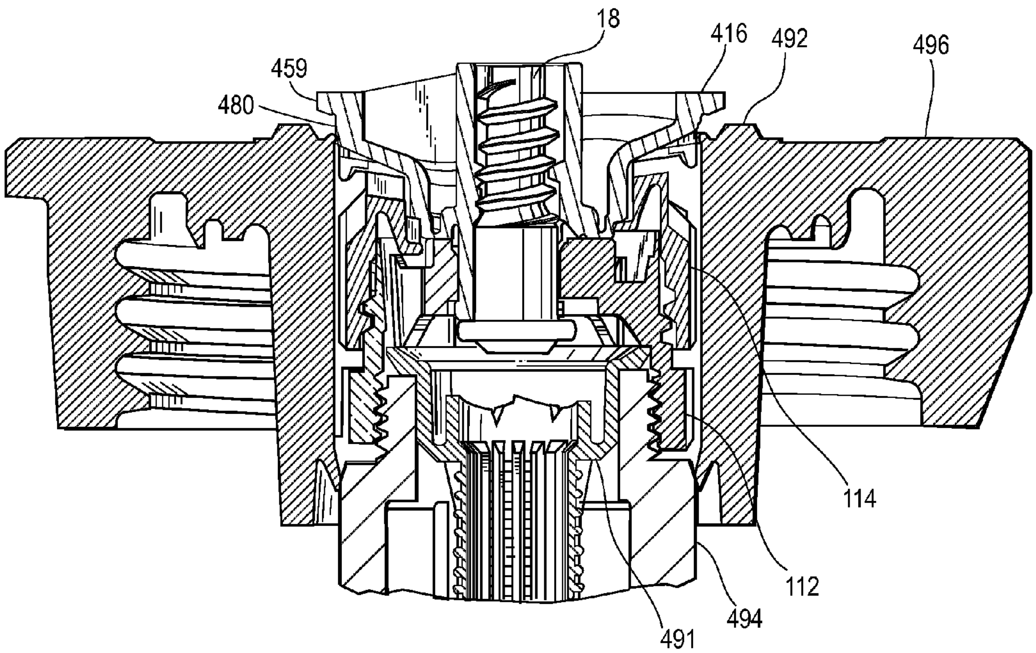
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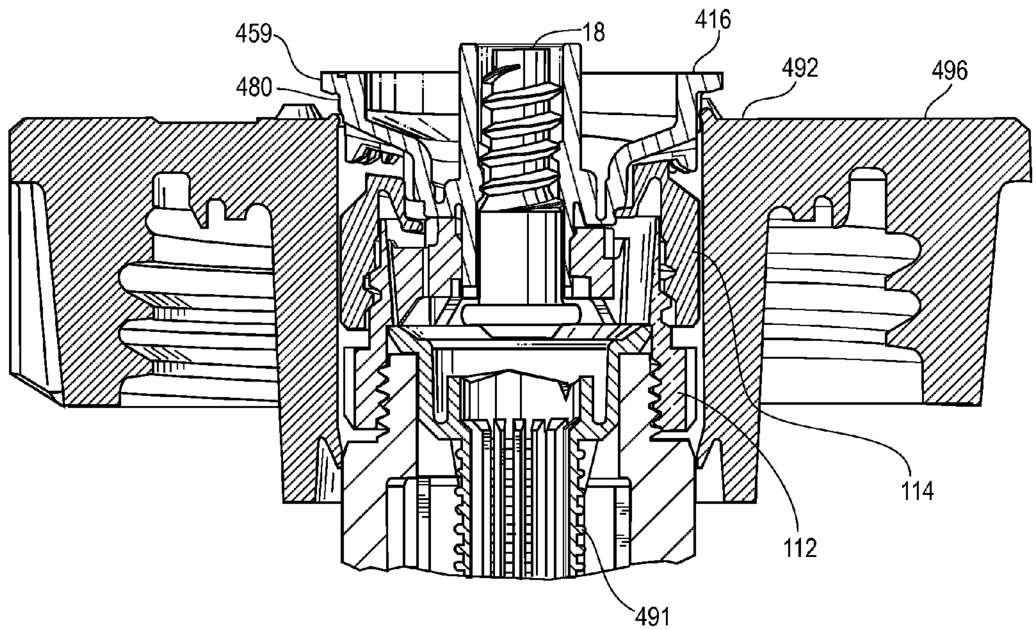
FIG. 33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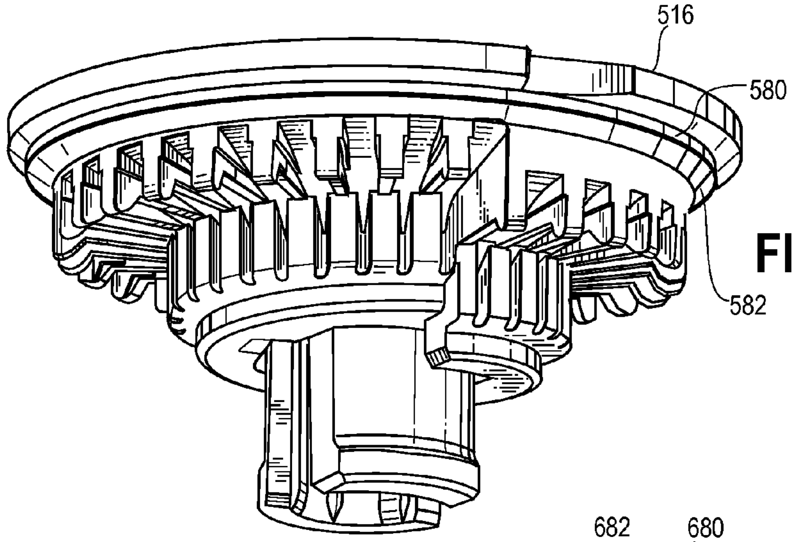

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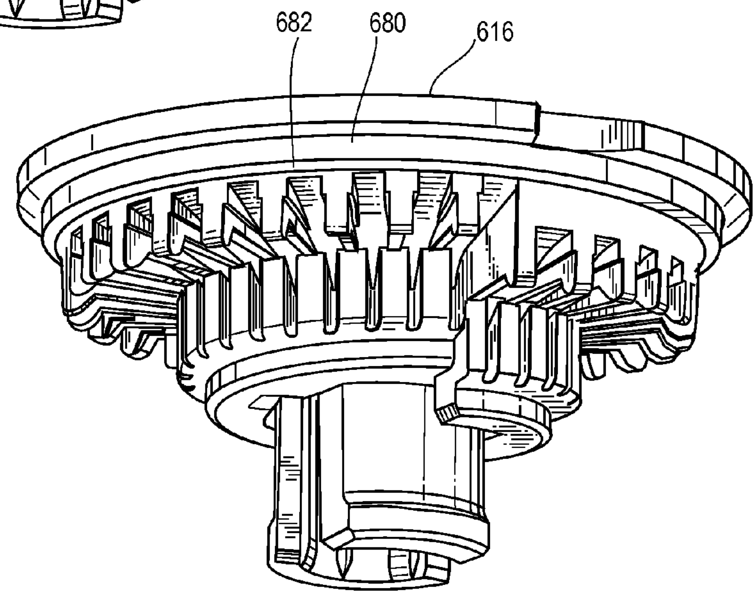

FIG. 35

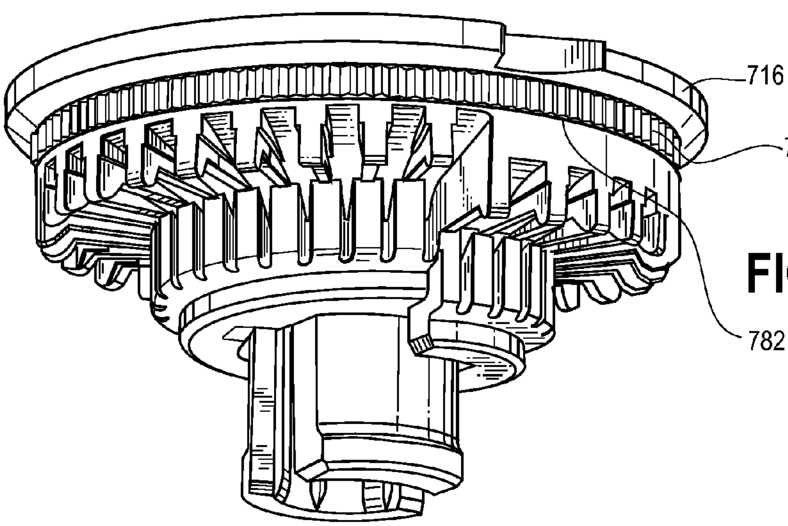

FIG. 36

IRRIGATION SPRINKLER NOZZLE

FIELD

This disclosure relates generally to an irrigation sprinkler nozzle and, in particular, to an irrigation sprinkler nozzle having a deflector and suitable for attachment to a riser of a pop-up irrigation device.

BACKGROUND

Efficient irrigation is a design objective of many different types of irrigation devices, such as gear-drive rotors, rotary spray nozzles, and fixed spray nozzles. That objective has been heightening due to concerns at the federal, state and local levels of government regarding the efficient usage of water. Over time, irrigation devices have become more efficient at using water in response to these concerns. However, those concerns are ongoing as demand for water increases.

As typical irrigation sprinkler devices project streams or sprays of water from a central location, there is inherently a variance in the amount of water that is projected to areas around the location of the device. For example, there may be a greater amount of water deposited further from the device than closer to the device. This can be disadvantageous because it means that some of the area to be watered will be over watered and some of the area to be watered will receive the desired about of water or, conversely, some of the area to be watered will receive the desired amount of water and some will receive less than the desired about of water. In other words, the distribution of water from a single device is often not uniform.

One measure of how uniformly water is applied to an area being watered is called Distribution Uniformity "DU", which is expressed as a percentage. One common measure of Distribution Uniformity is the Lower Quarter Distribution Uniformity ("DU_{lq}"), which is a measure of the average of the lowest quarter of samples, divided by the average of all samples:

$$DU_{lq} = \frac{\text{Average Catch of Lower Quarter} \times 100}{\text{Average Catch Overall}}$$

For example, if all samples are equal, the DU is 100%. If a proportion of the area greater than 25% receives zero application the DU will be 0%. DU can be used to determine the total watering requirement during irrigation scheduling. For example, one may want to apply not less than one inch of water to the area being watered. If the DU were 75%, then the total amount to be applied would be the desired about of water (one inch) divided by the DU (75%), or 1.33 inches of water would be required so that only a very small area receives less than one inch of water. The lower the DU, the less efficient the distribution and the more water that must be applied to meet the minimum desired. This can result in undesirable over watering in one area in order to ensure that another area receives the minimum water desired.

Another measurement is called the Scheduling Coefficient ("SC"). Unlike the DU, the scheduling coefficient does not measure average uniformity. Instead, it is a direct indication of the dryness of the driest turf areas (critical areas). The measurement is called the Scheduling Coefficient because it can play a role in establishing irrigation times. It is based on the critical area to be watered. To calculate the SC, one first identifies the critical area in the water application pattern

which is receiving the least amount of water. The amount of water applied to this critical area is divided into the average amount of water applied throughout the irrigated area to obtain the Schedule Coefficient. The scheduling coefficient indicates the amount of extra watering needed to adequately irrigate the critical area. If perfect uniformity were obtained, the scheduling coefficient would be 1.0 (no extra watering needed to adequately irrigate the critical area). By way of example, assume that an irrigation pattern has a scheduling coefficient of 1.8. After 15 minutes of irrigation, a critical area would still be under-watered due to non-uniformity. It will take an additional 12 minutes (15 minutes×1.8) to apply an adequate amount of water to the critical area (or 27 minutes total). While that is the amount of time needed to water the critical area, the result is that other areas will be over-watered.

There are many applications where conventional spray nozzle irrigation devices are desirable for use. Unfortunately, conventional spray nozzle irrigation devices can undesirably have lower DU_{lq} values. For example, some conventional fixed spray devices can have DU_{lq} values of about 65% and be considered to have a very good rating, DU_{lq} values of about 70% for rotors are considered to have a very good rating.

Efficient irrigation can include properly sizing spray nozzle irrigation devices for the areas to be irrigated. Different nozzles can be provided with flow rates each resulting in different radius of throw. However, the sizes of flow passages in the nozzles can be reduced in order to achieve reduced flow rates. Reduced sizes of flow passages can potentially lead to increased retention of grit and other debris in the flow passages. For example, in some circumstances downstream debris can enter flow passages when the riser with an attached nozzle is moved from an extended position to a retracted position in the region between the riser and nozzle and a surrounding seal, such as a wiper seal, of a housing.

SUMMARY

An irrigation nozzle is provided that is attachable to a riser of a pop-up irrigation device and is configured for reducing the distance relative to a seal of the irrigation device when the riser is in a retracted position and for discharging water when the riser is in an extended position. The nozzle can optionally be configured for forming at least a partial seal with a seal of the pop-up irrigation device, such as a wiper seal surrounding an opening through which the riser extends and retracts. The reduced distance can be effective to restrict entry of grit and other debris into the nozzle when the riser is returning to its retracted position and/or when the riser is in its retracted position. In the case where a seal is optionally formed, the seal between the nozzle and the seal of the pop-up irrigation device preferably, though not necessarily, has at least some vertical abutment, substantially parallel to the longitudinal axis of the riser. Indeed, there may only be vertical abutment in some circumstances. The reduced distance can be relative to one or more discharge openings of the nozzle.

The nozzle can include a base having a first end portion adapted for attachment to the riser and a second end portion. The nozzle also includes a deflector to deflect water through at least one discharge opening, such as a plurality of channels defined between ribs depending from an underside of the deflector. The base and deflector can be secured relative to each other, including in a fixed manner, or of integral, once piece construction. The deflector has an axial span positioned between outwardly facing exit openings of the channels and a top of the deflector and extending circumferentially about the deflector. The span has an outwardly projecting sealing pad extending substantially continuously about the circumfer-

ence of the span and positioned radially outwardly beyond the at least one discharge opening and radially inwardly relative to the top of the deflector, such as an outermost portion of the top of the deflector. The sealing pad is configured for reducing the distance relative to the seal of the irrigation device when the riser is in a retracted position as compared to at the at least one discharge opening to restrict entry of grit and other debris into the irrigation device.

The nozzle can be of different types, such as having a fixed or rotary deflector, a fixed or arcuately adjustable spray or stream pattern. For some types of nozzles, there may be multiple deflectors, each having one discharge opening or multiple discharge openings. The nozzle can also be part of a rotary irrigation device, for example, with the nozzle driven for rotation.

The sealing pad can extending continuous about the perimeter of the nozzle, or, alternatively, the sealing pad can include one or more gaps through which water can drain into the irrigation device when the riser is in the retracted position. The provision of the gap can provide an alternative path for fluid to enter into the interior of the irrigation device. The intentional provision of an flow path into the irrigation device can advantageously be used to direct at least some of entering water into areas of the device where debris is less likely to accumulate, such as between the exterior of the nozzle and the interior of the housing of the irrigation device, as opposed to within the interior of the nozzle itself. The gaps are particularly advantageous when there is seal or reduced distance formed only partially between the sealing pad and the seal of the irrigation device, such as when one part of the circumference nozzle is sealed or more closely spaced but not another part.

The sealing pad can have a constant, axially extending width. Alternatively, the sealing pad can have a variable width. For instance, the sealing pad can terminate with a step adjacent to the exit openings of the channels. The step being helical such that the sealing pad has a varying, axially extending width, as can be particularly suitable for adjustable arc nozzles. However, non-adjustable arc nozzles and even rotary nozzles can also incorporate the sealing pad.

If arcuately adjustable, the irrigation nozzle can have a first helical surface fixed relative to the base and a second helical surface moveable relative to the base. The first and second helical surfaces can cooperating to define an arcuate flow passage adjustable in size to determine an arc of distribution upon relative rotation between the first and second helical surfaces. A depending neck of the deflector can include the first helical surface and a collar rotatable relative to the deflector and the base can includes the second helical surface. The neck of the deflector can include a plurality of flow notches disposed about its outer periphery, the flow notches are aligned with the channels of the deflector. The nozzle can be configured such that the second helical surface is biased into a plurality of preset positions relative to the first helical surface.

The deflector can optionally be configured for high efficiency irrigation, such as by providing depending ribs of the deflector with outwardly-extending step at least partially along the length of the ribs such that a micro-ramp extends into the channels for directing a portion of the water flow.

The irrigation nozzle can be provided, such as when installed or in use, in combination with a pop-up irrigation device having a riser. The nozzle and, in particular the sealing pad, can be configured for sealing against a seal of the irrigation device when the riser is in a retracted position, or forming a reduced distance relative thereto, and for discharging water when the riser is in an extended position. The seal of the irrigation device can surround the riser when the riser is in the extended position.

A method of irrigating using the nozzle having the sealing pad and the pop-up irrigation device described herein can also be provided. The method includes discharging water when the riser is in the extended position and forming a seal between the sealing pad of the deflector of the nozzle and the seal of the irrigation device, or alternatively, a reduced distance relative thereto, when the riser is in the retracted position. The method can optionally include draining fluid into the irrigation device when the riser is in the retracted position through at least one drain path, such a gap in the sealing pad or a space between the sealing pad and the seal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective view of an exemplary embodiment of a variable arc irrigation nozzle, depicting a deflector, a collar, a base and an adjustment screw, where the deflector includes a plurality of radially-extending ribs forming channels for water flow therebetween, the ribs having micro-ramps configured for providing different aspects of the spray pattern;

FIG. **2** is a perspective view of the variable arc irrigation nozzle of FIG. **1** in an assembled configuration;

FIG. **3** is a top plan view of the assembled variable arc irrigation nozzle of FIG. **1**;

FIG. **4** is a cross-section view of the assembled variable arc irrigation nozzle taken along line IV-IV of FIG. **3**;

FIG. **5** is a cross-section view of the assembled variable arc irrigation nozzle similar to FIG. **4**, but showing diagrammatic flow paths discharging from the nozzle;

FIG. **6** is a top plan view of the base of the variable arc irrigation nozzle of FIG. **1**;

FIG. **7** is a perspective view of the collar of the variable arc irrigation nozzle of FIG. **1**;

FIG. **8** is a perspective view of the underside of the deflector of the variable arc irrigation nozzle of FIG. **1**;

FIG. **9** is a detailed perspective view of some of the ribs on the underside of the deflector of the variable arc irrigation nozzle of FIG. **1**;

FIG. **10** is a detailed bottom plan view of a portion of the underside of the deflector of the variable arc irrigation nozzle of FIG. **1**;

FIG. **11** is a perspective view of a section of the deflector of the variable arc irrigation nozzle of FIG. **1** showing details of the ribs;

FIG. **12** is a side elevation view of the deflector of the variable arc irrigation nozzle of FIG. **1**;

FIG. **13** is an image based upon CFD analysis of water flow along the ribs of the variable arc irrigation nozzle of FIG. **1**;

FIG. **14** is a schematic diagram depicting an idealized flow discharging from the variable arc irrigation nozzle of FIG. **1**;

FIG. **15** is a partial section view of an alternative exemplary embodiment of a variable arc irrigation nozzle similar to that of FIG. **1**, but configured for indexing the arcuate position of the collar relative to the deflector and base;

FIG. **16** is a cut-away perspective view of the top of the base of the nozzle of FIG. **15**, showing an upstanding cantilever spring;

FIG. **17** is a cut-away perspective view of the bottom of the collar of the nozzle of FIG. **15**, showing notches positioned to cooperate with the cantilever spring for indexing the rotation of the collar relative to the deflector and base;

FIG. **18** is a detailed view of region XVIII of FIG. **16**, showing the cantilever spring;

FIG. **19** is a detailed view of region XIX of FIG. **15**, showing the cantilever spring of the base;

FIG. **20** is a partial section view of another alternative exemplary embodiment of a variable arc irrigation nozzle similar to that of FIG. **15**, but having a different structure for indexing the arcuate position of the collar relative to the deflector and base, such structure including a detent spring;

FIG. **21** is a perspective view of the detent spring of FIG. **20**;

FIG. **22** is a perspective view of an exemplary embodiment of an alternative base having a plurality of radially extending ribs for reducing cross-sectional flow area through the nozzle;

FIG. **23** is a top plan view of the base of FIG. **22**;

FIG. **24** is a sectional of another alternative exemplary embodiment of a variable arc irrigation nozzle similar to that of FIG. **1**, but incorporating the base of FIG. **22**;

FIG. **25** is a perspective view of an alternative exemplary embodiment of a deflector similar to those depicted in prior figures, but having a sealing pad configured for reducing the distance by, in this example, sealing against a seal of an irrigation device when in a closed position;

FIG. **26** is a bottom plan view of the alternative deflector of FIG. **25** showing a plurality of gaps in the sealing pad;

FIG. **27** is a detailed view of the alternative deflector of FIG. **26** as indicated thereon, showing a helical transition portion of the sealing pad;

FIG. **28** is a detailed view of the alternative deflector of FIG. **26** as indicated thereon, showing a one of the gaps in the sealing pad;

FIG. **29** is a top plan view of the alternative deflector incorporated into a spray nozzle attached to a riser of an irrigation device, with the riser being in retracted position;

FIG. **30** is a partial cross section view of the deflector of the spray nozzle of FIG. **1**—lacking a sealing pad—attached to a riser of an irrigation device in a retracted position, showing the deflector inwardly spaced from the seal;

FIG. **31** is a partial cross section view of the alternative deflector of FIG. **25** attached to a riser of an irrigation device in a retracted position, the showing the sealing pad forming a reduced distance relative to the seal by sealing against the seal of the irrigation device;

FIG. **32** is a cross section view of the alternative deflector of FIG. **25** taken along line **32-32** of FIG. **29**, showing sealing on the left side and no sealing on the right side; and

FIG. **33** is a cross section view of the alternative deflector of FIG. **25** taken along line **33-33** of FIG. **29**, showing no sealing on the left side and sealing on the right side.

DETAILED DESCRIPTION

As shown in the exemplary drawings, new and improved sprinkler spray nozzles for use in irrigation are provided. Each of the spray nozzles has a deflector that provides for the separation of discharging water into different sprays in order to improve the overall spray pattern and, in particular, the DU_{lq} and SC values associated with the spray nozzle. Unlike conventional spray nozzles, which often have deflectors with simple, radially-extending vanes, the exemplary embodiments each have a deflector with depending ribs, where the ribs in turn each have one or more micro-ramps or other structures protruding into the flow paths of the water which guide the deflected water flow in different sprays which can have different characteristics. The different sprays with the different characteristics combine to provide for an improved spray pattern. Moreover, the spray pattern can be tailored by adjusting the geometries of the micro-ramps and the ribs depending upon the desired application or irrigation spray pattern. In one aspect, the deflector can receive discharging water from an arcuately-adjustable opening such that the arc of the spray pattern can be adjusted. However, the deflector described herein and, in particular, the division of the deflected fluid, can also be incorporated into a fixed spray-type sprinkler nozzle or a rotary-type sprinkler nozzle.

In an exemplary embodiment, described in U.S. Pat. Publ. No. 2011/0248093, which is hereby incorporated by reference in its entirety, a spray nozzle **10** for an irrigation device includes a base **12**, a collar **14**, a deflector **16** and a screw **18**, as illustrated in FIG. **1**. The base **12** includes a lower skirt **20** and an upper skirt **22**, both surrounding a central opening. The lower skirt **20** includes internal threads **40** (illustrated in FIG. **4**) to allow the base **12** (and hence the assembled nozzle **10**) to be threadingly connected to a riser, stand or the like of a sprinkler for receiving pressurized water. The upper skirt includes external threading **24** configured to mate with internal threading **42** of the collar **14**, as shown in FIG. **4**. The collar **14** can be rotated relative to the base **12** along the mating threads **24** and **42** such that the collar **14** can rotate about the base **12**. The deflector **16** includes an upper deflector surface **58** with a depending neck **50**, as illustrated in FIG. **12**. The deflector surface **58** is disposed on an opposite side of the collar **14** from the base **12**, and the neck **50** of the deflector **16** extends through the collar **14** and partially into the central opening of the base **12**, as depicted in FIG. **4**. The depending neck **50** of the deflector **16** is adapted to be attached to the base **12**, as will be described in greater detail herein, such that the deflector **16** is not rotatable relative to the base **12**. The screw **18** may be an adjustable flow rate adjustment screw to regulate water flow through the nozzle **10**.

The deflector **16** is attached to the base **12** via engagement between a pair of depending prongs **46** and **48** of the neck **50** and structure surrounding the central opening of the base **12**. More specifically, the base **12** includes an interior center disc **26** supported in spaced relation from the upper skirt **22** via a plurality of connecting webs **30**, as depicted in FIG. **6**. The central opening **28** extends through the disc **26**. Barbed ends of the prongs **46** and **48** are configured to extend through the central opening **28** to form a cantilever snap fit to secure the deflector **16** relative to the base **12** with the collar **14** therebetween. Further, the central opening **28** is optionally key-shaped or otherwise asymmetric in at least one direction. When one of the prongs **48** is larger than the other of the prongs **46** in its arcuate extent, as depicted in FIG. **8**, the key-shaped central opening **28** and the differently-sized prongs **46** and **48** can cooperate to ensure that the deflector **16** can only be attached to the base **12** in a single preferred orientation.

The illustrated embodiment of the nozzle **10** includes variable arc capability such that the arcuate extent of the spray pattern emanating from the nozzle **10** can be adjusted. The collar **14** includes a radially-inward extending helical ledge **32**, as illustrated in FIG. **7**. Ends of the ledge **32** are axially spaced and are connected by an axially-extending wall **34**. The ledge **32** has an upwardly-facing surface and a radially-inward edge surface. An upper face **36** of the collar **14** is also helical, having the same pitch as the ledge **32** and with ends thereof joined by an axially extending face wall **38**, also as illustrated in FIG. **7**. The neck **50** of the deflector **16** includes a downward-facing helical surface **55** and a depending, radially-outward facing helical wall **52**, as illustrated in FIG. **8**, both of which have the same pitch as the ledge **32** of the collar **14**. The downward-facing helical surface **55** of the deflector **16** lies over the ledge **32** of the collar **14**.

As the collar **14** is rotated relative to the deflector **16**, however, the radially-inward edge surface of ledge **32** of the collar **14** is brought into or out of sliding and sealing engagement with the helical wall **52** of the deflector **16** in order to increase or decrease the arcuate extent of a water discharge opening. In a fully closed position, the radially-inward edge surface of the ledge **32** of the collar and the helical wall **52** of the deflector **16** are sealingly engaged to block water flow through the spray nozzle. Rotation of the collar **14** then increase the axially spacing between the edge surface of the ledge **32** of the collar and the helical wall **52** of the deflector **16** such that they have overlying segments that are not sealingly engaged through which the water discharge opening is defined. In this manner, the arcuate extent of the water discharge opening, and thereby the arcuate extent of the spray, can be readily adjusted. By way of example, the collar **14** in FIG. **4** has been rotated to a position whereby the water discharge opening is about 180-degrees. As can be seen on the left side of FIG. **4**, the edge surface of the ledge **32** of the collar **14** is sealingly engaged with the helical wall **52** of the deflector **16** but on the right side they are axially spaced.

Turning now to details of the upper deflector surface **58** of the deflector **16**, a plurality of radially-extending ribs **60** depend from the underside, as illustrated in FIGS. **8-11**. Discharge channels for water are formed between adjacent ribs and have bottoms **62** coinciding with the underside of the upper deflector surface **58**. The ribs **60** are each configured to divide the water flow through the channels into different sprays directed to different areas and thereby having different characteristics. The different sprays with the different characteristics are combined to provide for an improved spray pattern having improved DU_{lq} and SC values as compared to conventional spray nozzles, including conventional spray nozzles configured for variable arc adjustment, as will be discussed in greater detail herein.

Each of the ribs **60** has an inner end adjacent the neck **50**, and outer end radially outward from the neck **50**, a pair of sidewalls and a bottom wall **70**. As the ribs **60** are each generally symmetric about a radially-extending line, only one of the sides of a representative rib **60** will be described with it being understood that the opposite side of that same rib **60** has the same structure. With reference to FIGS. **10** and **11**, the rib **60** has a first step **66** forming in part a first micro-ramp and a second step **68** defining in part a second micro-ramp. The first step **66** is generally linear and positioned at an angle closer to perpendicular relative to a central axis of the deflector as compared to the bottom **62** of the upper deflector surface **58**, as shown in FIG. **11**. The second step **68** is segmented, having an inner portion **68***a* that extends closer to perpendicular relative to the central axis as compared to an outer portion **68***b*, which has a sharp downward angle.

The first and second steps **66** and **68** divide the sidewall into three portions having different thicknesses: a first sidewall portion **63** disposed adjacent an outward region of the bottom **62** of the upper deflector surface **58**; a second, narrower sidewall portion **67** disposed partially on an opposite side of the first step **66** from the first sidewall portion **63**; and a third, yet narrower sidewall portion **65** having an outer region disposed on an opposite side of the second step **68** from the first step **66**, a middle region disposed on an opposite side of the first step **66** from the bottom **62** of the upper deflector surface **58**, and an inner region disposed adjacent the bottom **62**, as depicted in FIG. **11**. The outer portion **68***b* of the second step **68** is spaced inwardly from the outer end of the rib **60** by a second sidewall portion **67**. An inclined sidewall segment **69** is disposed radially inward from the second sidewall portion **67**.

The underside or bottom wall **70** of the rib **60** has a first, generally linear segment **70***a* positioned at an angle closer to perpendicular relative to a central axis of the deflector **16** as compared to an inner, inclined intermediate segment **70***b* and the bottom **62** of the upper deflector surface **58**, as shown in FIG. **11**. An outer, inclined intermediate segment **70***c* is closer to perpendicular than the inner intermediate segment **70***b* but not as close to perpendicular as the first segment **70***a*. An upwardly curved segment **70***d* is disposed at the end of the rib **60**.

The geometries of the ribs **60** and the bottom **62** of the of the upper deflector surface **58** cooperate to define a plurality of micro-ramps which divide the discharging water into sprays having differing characteristics. More specifically, and with reference to FIGS. **5** and **14**, there is a first spray B, a second spray C, a mid-range spray D and a close-in spray E as measured from the location A of the spray nozzle **10**. The first and second sprays B and C may combine or may be coextensive to form a primary spray. The first and second sprays B and C can have the furthest throw, but may be angularly offset from each other to minimize gaps between the sprays. The mid-range spray D and the close-in spray E are progressively closer to the location A of the spray nozzle **10**, as depicted in FIG. **14**. When the different sprays are combined, the result is a spray pattern which provides for improved DU_{lq} and SC values as compared to conventional arcuately adjustable, fixed spray nozzles.

The micro-ramp associated with the first spray B is defined by the first step **66** and the adjacent portions of the sidewall of the rib **60**, such as portion of sidewall segment **65**, **69** and **67**, with reference to FIG. **11**. The micro-ramp associated with the second spray C is defined by the bottom **62** of the upper deflector surface **58** and the adjacent portions of the sidewall of the rib **60**, such as segment **63**, also with reference to FIG. **11**. As can be seen from the image of FIG. **13** from the CFD analysis of the water flow, the vast majority of the water tends to flow immediately adjacent the ribs **60** and the bottom **62** of the channels and opposed to evenly filling the space between the ribs **60**. Accordingly, the position of the first step **66** relative to the bottom **62** can be selected to vary the amount or fraction of the water flowing along the first micro-ramp as opposed to the second micro-ramp. For example, moving the first step **66** closer to the bottom **62** will increase the depth of the first micro-ramp and thereby increase its fraction of water as compared to the second micro-ramp. As shown in this example, there is a greater fraction of the water flow in the first micro-ramp as compared to the second micro-ramp.

In order to provide for the phase shifting of the spray from the first micro-ramp relative to the spray from the second micro-ramp, the outward ends **67** of the sidewalls of the ribs **60** narrow or taper toward each other, such that a pair of sub-sprays each flowing along the primary micro-ramp on opposite sides of the same rib **60** combine to form a common primary spray. This angularly shifts the first spray from being directly radially outward in the direction of the bottom **62** of the channels.

The micro-ramp associated with the mid-range spray D is defined by second step **68** and those portions of the sidewall of the rib **60** on an opposite thereof from the first step **66**, such as a portion of sidewall segments **65**. The sharply inclined end segment **68***b* is configured to direct the water spray more downwardly as compared to the spray from the first micro-ramp. Finally, the micro-ramp associated with the close-in spray E is defined by the underside **70** of the rib **60**, including the downturned end segments **70***b* and **70***c*, for directing the water flow a shorter throw as compared to the mid-range spray D, the second spray C and the first spray B. It will be understood that the geometries, angles and extend of the micro-ramps can be altered to tailor the resultant combined spray pattern. Further, while it is presently believed to be preferable to have all or nearly all (at least about 80%, 85%, 90%, or 95%) of the ribs **60** with the micro-ramps, it is foreseeable that in some circumstances it may be preferable to have less than all of the ribs include micro-ramps. For instance, the micro-ramps may be on only one side of each of the ribs, may be in alternating patterns, or the like.

Extending about the outer circumference of a portion of the neck **50** of the deflector **16** are a plurality of radially-projecting and axially-extending ribs **54** which are spaced by axially-extending flow notches **56**. The flow notches **56** have an upstream entrance disposed radially outward from the downwardly-facing helical wall **55**, as illustrated in FIG. **8**. A downstream exit of the flow notches **56** is aligned with the channels between adjacent ribs **60**, as illustrated in FIG. **9**. An inclined ramp **64** at the intersection of each of the channels and the flow notches **56** can assist in gradually turning the flow from being generally axially to projecting generally radially outwardly. The flow notches **56** can improve the ability of the spray nozzle **10** to provide for a matched precipitation rate, particularly desirable given the adjustable nature of the arcuate extent of the spray pattern from the spray nozzle **10**. In other words, the flow notches **56** contribute to having proportional volumes of water discharged for given arcuate spray pattern settings.

As described above, and with reference to FIG. **4**, the radially-inward edge surface of ledge **32** of the collar **14** is brought into or out of sliding and sealing engagement with the helical wall **52** of the deflector **16** in order to increase or decrease the arcuate extent of a water discharge opening and thus flow through the flow notches **56** disclosed about the neck **50** of the deflector **16**. As can be appreciated from the foregoing description and the figures of the first exemplary embodiment, the arcuate extent of the water discharge opening is bounded at one end by a fixed edge formed by a step **53**, shown in FIG. **8**, in the helical portion of the downward-facing helical surface **55** of the deflector **16**. The other, moveable end of the arcuate extent of the water discharge opening is bounded by the axially-extending wall **34** between axially-offset ends of the helical ledge **32**, as shown in FIG. **7**.

It can be preferable to ensure that the moveable end of the arcuate extent of the water discharge opening is aligned with one of the ribs **54** positioned between adjacent flow notches **56**. In other words, it can be preferable to ensure that the last flow notch **56** through which fluid flows at the moveable edge of the spray pattern is completely open—as opposed to partially blocked. A partially blocked flow notch **56** can result in a spray pattern with an errant edge portion as compared to the remainder of the spray pattern. In order to ensure that the last flow notch **56** is not partially blocked positive indexing is provided for the adjustment of the collar **14** in positions whereby the radially-inward edge surface of ledge coinciding with the axially-extending wall **34** has a plurality of preset positions where it is aligned or substantially aligned with a rib **54** as opposed to a notch **56**. While possible for substantial misalignment between positions, there is a bias for the collar **14** to be in one of the plurality of preset conditions aligned with a rib **54** as opposed to a notch **56**. The bias can be such that it requires a greater force to rotate the collar **14** out of alignment, i.e., away from being in a preset position, than between alignments, i.e., between preset positions.

Turning to an alternative exemplary embodiment, illustrated in FIGS. **15-19** and described in U.S. Pat. Publ. No. 2011/0248094, which is hereby incorporated by reference in its entirety, an adjustable arc irrigation nozzle **100** is provided with positive indexing for adjusting the arcuate extent of the spay pattern. Similar to the exemplary embodiment of FIGS. **1-14**, and with like reference numbers representing similar or like components, the alternative exemplary embodiment of an adjustable arc irrigation nozzle **100** includes a base **112** fixed relative to a deflector **16** with an axially interposed collar **114** movable, e.g., rotatable, to adjust the arcuate extent of a discharge opening. Although the exemplary embodiments herein utilize rotation to adjust the discharge opening, other types of relative movement could also be used, such as axial movement alone or in combination with rotational movement. A screw **18** is provided for adjust the radius of throw of the spray pattern emanating from the nozzle **100**. These components are the same as described in the previous embodiment, with the following exceptions relating to the incorporation of the positive indexing of the collar **114** relative to the base **112** and deflector **16**. While the collar **114** is described herein and depicted in several embodiments, the term collar can refer to any member moveable for adjustment, whether externally accessible or internally accessible.

In order to achieve the positive indexing, the base **112** includes a spring **180** cantilevered upwardly from one of the connecting webs **30** supporting the interior center disc **26** in spaced relation from the upper skirt **22**, as depicted in FIG. **16**. The spring **180** is positioned to be biased into detents **192** formed about an inner surface of the collar **114**, where the detents **192** are spaced by relatively raised segments **190** (which may be flush with the remainder of the immediately adjacent surface). Each of the detents **192** corresponds to a preset rotational position of the collar **114** relative to the base **112** and the deflector **16** and, hence, a corresponding preset size of the adjustable arcuate discharge opening. The spring **180** is preferably biased into an aligned detent **192**, which biasing force can be overcome to move the spring **180** out of engagement with the detent **192** so that the spring **180** can slide along the intermediate raised segments **190** to the next detent **192** when the collar **114** is rotated relative to the base **112** and the deflector **16**. The spring **180** can snap at least partially into an aligned detent **192** such that there is an audible and/or tactile response to a user.

The spring **180** is integrally formed with the base **112** and includes a generally circumferentially aligned, axially extending tapered, upstanding portion **182**. Facing radially inward from the upstanding portion **182** and also axially extending is a projecting rib **184** being generally semi-circular in shape and generally centered on the upstanding portion **182**, as illustrated in FIG. **19**. The detents **192** and intermediate raised segments **190** are formed in a radially-outward facing surface of a downwardly-depending wall **190** extending between a top portion **194** of the collar **114** and the radially-inward extending helical ledge **32**, as illustrated in FIG. **17**. Each of the detents **192** includes an arcuate back wall **198**, a top wall **196** and a pair of inclined or curved entrance and exit sidewalls **199**. The bottom and front of the detent **192** are open for receiving a portion of the spring **180** when aligned therewith. When the nozzle **100** is assembled, the spring **180** is received within a recess **186** formed between a radially-inward facing surface of an outer wall **188** of the collar **114** and the downwardly-depending wall **190**.

More specifically, the projecting rib **184** of the spring **180** is dimensioned to be substantially received within the detent **192**, as illustrated in FIGS. **15** and **18**. The number and position of detents **192** corresponds to the number of ribs **54** between flow notches **56**, such that the radially-inward edge surface of ledge **32** coinciding with the axially-extending wall **34** is aligned with a rib **54** as opposed to a flow notch **56** of the deflector **116**. The detents **192** do not need to be directly aligned with the ribs **54**, provided that the relative positions between the spring **180** and detents **192** result in unblocked or substantially unblocked last flow notch **56**.

In another alternative exemplary embodiment, illustrated in FIGS. **20** and **21**, an adjustable arc irrigation nozzle **200** is provided with positive indexing for adjusting the arcuate extent of the spay pattern. Similar to the exemplary embodiment of FIGS. **1-14**, and with like reference numbers representing similar or like components, the alternative exemplary embodiment of an adjustable arc irrigation nozzle **200** includes a base **12** fixed relative to a deflector **16** with an axially interposed collar **214** rotatable to adjust the arcuate extent of the discharge opening. A screw is provided for adjust the radius of throw of the spray pattern emanating from the nozzle **200**. These components are the same as described in the previous embodiment, with the following exceptions relating to the incorporation of the positive indexing of the collar **214** relative to the base **12** and deflector **16**.

In this embodiment, a separate spring **202** is positioned to engage a series of detents **292** formed in the collar **214** to provide for positive indexing of the collar **214** relative to the base **12** and deflector **16**. The detents **292** are spaced by raised portions **290** and are positioned in a similar location as described in the prior embodiment but opening downward, as illustrated in FIG. **20**, as opposed to radially outward, as illustrated in FIG. **17**.

The spring **202** includes a closed, oval shaped portion **206**. A top wall **205** of the oval shaped portion **206** includes a projecting finger **204** which is configured to slide into and out of the detents **292** as the collar **214** is rotated. To facilitate such sliding, the leading and trailing edges of the finger **204** can be tapered, as illustrated in FIG. **21**. Depending from the oval shaped portion **206** and on an opposite side thereof from the finger **204** is a pair of opposing legs **201**. The legs **201** are spaced to permit the spring **202** to be attached to one of the connecting webs **30** supporting the interior center disc **26** in spaced relation from the upper skirt **22**, as depicted in FIG. **20**. In particular, the spacing between the legs **201** is selected to permit one of the webs **30** to be received therebetween. Tapered protuberances **203** at the ends of the legs **201** opposite the oval shaped portion **206** are configured to facilitate attachment and retainment of the spring **202** on the web **30**. In use, the top wall **205** of the oval shaped portion **206** can deflect toward the legs **201** when the finger **204** is urged in that direction as it moves out of a detent **292** and along an intermediate raised portion **290**, then provide a biasing force urging the finger **204** into engagement with a detent **292**.

While the description herein and the exemplary embodiments of FIGS. **15-21** are of an adjustable arc nozzle having the above-described flow notches **56** spaced by ribs **54**, the advantages of the positive indexing with preset positions are also applicable to other types of adjustable arc nozzles lacking such features. Those advantages include a tactile and/or audible indication that can be made when the collar **14** enters one of the preset positions as opposed to between preset positions to provide feedback to the user that the collar **14** is in one of the preset positions. Another advantage is the ability to provide preset positions corresponding to specific angles or increments of angles, e.g., a preset position every 3 degrees, 5 degrees, 10 degrees, 15 degrees, 30 degrees, 45 degrees or 90 degrees. Some of the preset positions may have a greater bias against removal as opposed to other preset positions. For example, a greater bias may exist for positions spaced 45 degrees apart as compared to other preset positions between each 45 degree position. This greater biasing could be achieved by having some of the detents deeper than other or by having the entrance and or exit side portions of the detents with different angles of inclination or radius of curvature. Further, the detents can be configured such that it is easier to overcome the spring bias in one direction as compared to an opposite direction. Yet another advantage of a bias against removal from a preset position is that the arcuate extent of the spray pattern can be less susceptible to unintentional change, such as do to bumping with landscape tools.

Furthermore, relying solely upon friction to maintain an arc setting is not longer necessary if the positive indexing is incorporated into a variable arc nozzle. This can advantageously mean that components can be designed for easier relative rotation to adjust the arcuate extent of a spray pattern with the biasing providing the ability to retain a desired setting. Moreover, the incorporation of positive indexing can reduce the impact of rotational torque degradation over time, such as due to plastic creep, as can occur in nozzles that rely solely upon friction to maintain an arc setting.

Although the springs **180** and **202** of the variable arc nozzles **100** and **200** have been described as being attached to or integral with the base **112** or **12** and the detents **192** and **292** being formed in the collar **114** or **214**, they could be reversed.

In the exemplary embodiments of a variable arc spray nozzle **10**, **100** and **200** depicted in the accompanying figures, the nozzles **10**, **100** and **200** may be configured to have a 12' throw. There may be thirty flow notches **56** feeding thirty channels separated by ribs **60**, with thirty ribs **60** total and one rib extending from the ends of the helically-inclined array of ribs **60**, which one rib lacks micro-ramps in the illustrated embodiment. For the nozzles **100** and **200** with positive indexing, there would be thirty detents **192**, with the last position corresponding to abutment of the one rib extending from the ends of the helically-inclined array of ribs **60** and the wall **34** between ends of the helical ledge **32** of the collar **14** or other similar structure on the collar **14**. Each of the axially-extending ribs projects outwardly about 0.0255 inches, has a width at its outward end of about 0.024 inches and adjacent ones form a flow notch **56** with an inward taper of about 6.2 degrees with a bottom radius of about 0.0125 inches. The length may be about 0.92 inches. The inclined ramp **64** may be outwardly-inclined at about 20 degrees relative to a central axis. The ribs **60** are spaced at about 10 degrees to about 12 degrees apart. The first step is between about 0.004 and 0.008 inches in width from the sidewall of the adjacent portion of the rib **60**, such as about 0.006 inches. A distal end of each of the ribs **60**, including the first step **66**, may be about 0.040 inches with about a 3 degree taper, with the portion on the opposite side of the step **66** from the bottom wall **62** being about 0.028 inches in width, with a proximate end of each of the ribs **60** being about 0.018 inches. The second step **68** may be between about 0.002 and 0.006 inches in width, such as about 0.004 inches in width. The angle of the linear portion **70***a* of the bottom wall **62** may be about 9 degrees toward a horizontal plane coinciding with the top of the deflector **16**, with the inward segment **70***b* being inclined about 50 degrees away from the plane and the intermediate segment **70***c* being inclined about 20 degrees away from the plane. While these dimensions are representative of the exemplary embodiment, they are not to be limiting, as different objectives can require variations in these dimensions, the addition or subtraction of the steps and/or micro-ramps, and other changes to the geometry to tailor the resultant spray pattern to a given objective.

An alternative base **312** can be used in place of the above-described bases **12** and **112**, as is depicted in FIGS. **22-24** and described in U.S. Pat. Publ. No. 2011/0248097, which is hereby incorporated by reference in its entirety. The alternative base **312** is configured to be used for reducing the flow through the nozzle **300** upstream of the deflector **16**. More specifically, the cross-sectional flow area upstream of the deflector **16** can be reduced in order to reduce the volume of flow through the nozzle **300**, and may be useful in reduced-radius applications. Radius reduction can alternatively or in addition be achieved by modifying the notches on the neck of the deflector **16**, such as by decreasing the flow area of the notches.

Turning to FIGS. **22** and **23**, the alternative base **312** is similar to the prior bases **12** and **112** in that it has a lower skirt **20** and an upper skirt **22** both surrounding a central opening. The lower skirt **20** includes internal threads **40** to allow the base **312** (and hence the assembled nozzle **300**) to be threadingly connected to a riser, stand or the like of a sprinkler for receiving pressurized water. The upper skirt **22** includes external threading **24** configured to mate with internal threading of the collar **214**, as shown in FIG. **24**. The collar **214** can be rotated relative to the base **312** along the mating threads. The base **312** and collar **214** can optionally be configured for indexing, such as by using the spring **180** and detents or the other mechanisms described herein.

The interior center disc **26** of the alternative base **312** includes a plurality of radially-outward extending ribs **316** disposed above the upper circumference thereof, as illustrated in FIGS. **22** and **23**. The ribs **316** define a plurality of flow passages **318** therebetween, and extend upward from a radially-extending ledge **314** of the disc **26**. When assembled with the deflector **16** and the collar **14** or **214**, as illustrated in FIG. **24**, the radially-inward edge surface of the ledge **32** of the collar **214** is adjacent to or abuts the outer periphery of the ribs **316** to further bound the flow passages **318**. The result is that water flowing through the nozzle **300** flows at least partially through the flow passages **318** between the ribs **316** before being discharged against the deflector **16**. The function of the ribs **316** is to reduce the cross-sectional flow area between the ledge **32** of the collar **14** or **214** and the adjacent portion of the base **312**, particularly compared to if the base **312** lacked the ribs **316**. In one particular example of a nozzle **300** configured for a 12' throw, the ribs **316** can be dimensioned to provide a reduction in flow rate of about 25%. For instance, the flow area without ribs can be about 0.034 inches-squared and with ribs can be about 0.26 inches-squared. The use of the ribs **316** can be advantageous when the distance between the radially-inward edge of the ledge **32** and the adjacent portion of the disc **26** of the base has already been minimized, such as based upon tolerances for manufacturing and the environment in which the nozzle operates. The flow passages **318** can optionally be the same in number and aligned with the notches and channels of the deflector **16**.

Although the ribs **316** illustrated herein are uniform in size and spacing about the base **312**, it is contemplated that they could vary in size, such as width, and spacing depending upon specific design needs that may arise. For example, the ribs could take the form of an undulating surface about the disc. Also, other obstructions in the flow path instead of ribs can be used to reduce the cross-sectional flow area upstream of the deflector surface. Furthermore, which the use of the ribs **316** for reducing cross-sectional flow area of the nozzle **300** is described and depicted with respect to a variable arc nozzle with a deflector having microramps and configured for indexing, the ribs **316** can be incorporated into a nozzle that is not configured for an adjustable arc, and/or not configured with micoramps, and/or not configured for indexing.

One of several alternative deflectors configured for reducing entrance of grit and other debris into the nozzle can be substituted for the deflectors in any of the nozzles discussed herein. The alternative deflectors, illustrated in FIGS. **25-36**, are similar in construction to the foregoing deflectors of the embodiments of FIGS. **1-24**. However, the alternative deflectors differ in that they each incorporate a sealing pad that is configured for reducing the distance relative to the seal of an irrigation device, such as by forming a seal therewith, when a riser to which the nozzle is attached is in a retracted position for the purpose of restricting fluid flow into the nozzle.

A pop-up irrigation device can include a housing and a cap. The cap can have an annular opening through which a riser is extensible when an interior of the housing is pressurized. The annular opening can include a surrounding seal, such as a wiper seal. The riser can include threads for the like for attachment of an irrigation nozzle. For nozzles with deflectors lacking the sealing pad described herein, when the riser is in its retracted position a radially outward surface of the deflector can be radially inwardly spaced from the wiper seal, as illustrated in FIG. **30**. The resultant space between the deflector and the wiper seal can disadvantageously result in a path for drain back of fluid into the interior of the nozzle and/or irrigation device, particularly immediately after the riser returns to its retracted position. When water drains back through the resultant space, grit and other debris entrained with the water can enter the nozzle or device, which can lead to clogging particularly in the case where internal features of the nozzle are reduced for purposes of reducing fluid flow for reduced-radius throw. The sealing pad of the alternative deflectors address the problems associated with drain back by at least partially forming a seal with the wiper seal when the riser to which the nozzle is attached is in a retracted position, as illustrated in FIGS. **31-33**. An example of an irrigation device to which the nozzle described herein can be attached to can be found in U.S. Pat. No. 6,997,393, which is hereby incorporate by reference in its entirety. For instance, the nozzle described herein can be attached to the riser instead of the nozzle shown in FIG. **1** of that patent. The nozzle described herein can be suitable for use, by way of example, with the 1800® Series pop-up spray head sprinklers sold by Rain Bird Corporation (Azusa, Calif.).

The deflector **416** of the first alternative embodiment is configured to be used in the above-described arcuately adjustable nozzles assemblies and for high efficiency flow. As such, it includes an upper deflector surface **58** with a plurality of depending ribs **60** defining flow channels **62** therebetween. The ribs **60** can include one or more microramps of the types described herein **66** and **68**. The deflector **416** has a centrally located, depending neck with a plurality of radially-projecting and axially extending ribs **54** which are separated by axially extending flow notches **56** for purposes of improving the ability to provide matched precipitation rates, as described above. A helical wall **52** of the deflector **416** is brought into or out of sliding and sealing engagement with the radially-inward edge surface of the ledge **32** of the collar **14** (or similar structure on other collar embodiments described herein) for purposes of increasing or decreasing the arcuate extent of a water discharge opening. Depending prongs **48** and **46** are configured to be received in an opening of a base to secure the deflector **416** relative to the base.

Turning now to details of the sealing pad, and with reference to a first exemplary embodiment of the alternative deflector illustrated in FIGS. **25-29** and **31-33**, the sealing pad **480** extends substantially continuously about the circumference of the deflector **416**. More specifically, the sealing pad **480** is positioned in an axial extending, circumferential region spanning below a flange **459** that forms part of the top of the deflector **416** and above an adjacent portion of the discharge openings **463** of flow channels **62** between adjacent ribs **60** on the underside **58** of the deflector **416**, as illustrated in FIG. **25**. The sealing pad **480** can have a width that extends less than the entire span of the region such that there is a portion **465** of the span without the sealing pad **480**, as illustrated, or the entire span. The sealing pad **480** can begin immediately below the flange and terminate at a step **482** extending radially inward toward the region and, in particular toward the portion **465** of the span without the sealing pad **480**. The step **482** can be inclined relative to a face of the sealing pad **480**, including normal thereto. The step **482** can be helical, such that it corresponds to a helically-arranged array of the ribs **60** with a transition **484** where the step **482** would begin to overlap itself if it were to continue on the same pitch.

When a nozzle incorporating the alternative deflector **416** is attached to a riser of an irrigation device and the riser is in its retracted position, the sealing pad **480** engages the wiper seal **492** to restrict or block ingress of water into the irrigation nozzle, as illustrated in FIG. **31**. As shown, the sealing interface has a vertical component, engaging a radially-outward part of the face of the sealing pad **480** and, in this example, the intersection between the face of the sealing pad **480** and the step **482**.

The step **482** of the sealing pad **480** of the first exemplary embodiment of the alternative deflector **416** extends substantially continuously about the circumference of the above-described span. By substantially continuous, what is meant is that the face (whether continuously or cumulatively) of the sealing pad **480** extends about more than half of the circumference of the span. The sealing pad **480** is interrupted by one or more gaps **486**, such as one, two, three, four or more gaps **486**, as shown in detail in FIG. **28**. The gaps **486** are preferably aligned with a front of the ribs **60** as opposed to being aligned with the channels **62** therebetween. As illustrated in FIG. **26**, there are three gaps **486** in the sealing pad **480**. The gaps **486** are positioned such that there is an immediately adjacent gap **486** to an arcuately adjustable end of the discharge opening. For example, the illustrated deflector of FIG. **26** has thirty deflectors. For a 90 degree setting, the first gap is aligned with the eighth rib from the fixed edge so that when the intervening channels are exposed, there is a gap that is immediately adjacent to the last exposed channel. Similarly, there are gaps after 180 degrees and 270 degrees.

The purpose of the gaps **486** is to provide for controlled drain back. By providing a predetermined path of water to drain back into, at least some of the water draining upstream can be directed, via the gaps **486**, into less sensitive areas. For example, the gaps **486** can direct fluid into the space between the irrigation device and the nozzle, as opposed to into the nozzle. Such gaps **486** can be particularly advantageous when the sealing pad **480** has a variable width. A variable width sealing pad **480** having a reduced width segment can result in no sealing adjacent the reduced width segment. Providing the gap **486** in the sealing pad **480** provides a controlled path for drain back as an alternative to the space between the wiper seal and the reduced with segment of the sealing pad **480**.

Other exemplary embodiments of the alternative deflector include sealing pads with different configurations, but are otherwise the same as those described above. For example, the deflector **516** of the embodiment of FIG. **34** includes a constant width sealing pad **580** with an angled step **582**. The deflector **616** of the embodiment of FIG. **35** includes a constant width sealing pad **680** with a normally-extending step **682**. The deflector **716** of the embodiment of FIG. **36** includes a constant width seal pad **780** with a series of radially extending teeth **782** that can provide filtering gaps for drain back.

It will be understood that various changes in the details, materials, and arrangements of parts and components, which have been herein described and illustrated in order to explain the nature of the invention may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims. For example, as described above the sealing pads can be incorporated into different types of nozzles than those illustrated in the figures.

The invention claimed is:

1. An irrigation nozzle attachable to a riser of a pop-up irrigation device, the nozzle configured for forming a seal or a reduced width opening relative to a seal of the irrigation device when the riser is in a retracted position and for discharging water when the riser is in an extended position, the nozzle comprising:

- a base having a first end portion adapted for attachment to the riser and a second end portion;
- a deflector to deflect water through at least one discharge opening, the deflector having an axial span positioned between the at least one discharge opening and a top of the deflector and extending circumferentially about the deflector, the span having an outwardly projecting, sealing pad extending substantially continuously about the circumference of the span and positioned radially outwardly beyond the at least one discharge opening and radially inwardly relative to the top of the deflector, the sealing pad being configured for reducing the distance relative to the seal of the irrigation device when the riser is in a retracted position as compared to at the at least one discharge opening to restrict entry of grit and other debris into the irrigation device.

2. The irrigation nozzle of claim **1**, wherein the sealing pad is continuous.

3. The irrigation nozzle of claim **1**, wherein the sealing pad has at least one gap through which water can drain into the irrigation device when the riser is in the retracted position.

4. The irrigation nozzle of claim **3**, wherein the sealing pad has four or fewer gaps.

5. The irrigation nozzle of claim **3**, wherein the sealing pad has more than four equally-spaced gaps.

6. The irrigation nozzle of claim **1**, wherein the sealing pad has a constant, axially extending width.

7. The irrigation nozzle of claim **1**, wherein a plurality of discharge openings are provided between ribs depending from an underside of the deflector.

8. The irrigation nozzle of claim **7**, wherein the deflector is adapted to rotate relative to the base when impinged by water.

9. The irrigation nozzle of claim **7**, wherein the sealing pad terminates with a step adjacent to the plurality of discharge openings, the step being helical such that the sealing pad has a varying, axially extending width.

10. The irrigation nozzle of claim **7**, further comprising:

- a first helical surface fixed relative to the base;
- a second helical surface moveable relative to the base, the first and second helical surfaces cooperating to define an arcuate flow passage adjustable in size to determine an arc of spray distribution upon relative rotation between the first and second helical surfaces.

11. The irrigation nozzle of claim **10**, wherein a depending neck of the deflector includes the first helical surface and a collar rotatable relative to the deflector and the base includes the second helical surface.

12. The irrigation nozzle of claim **11**, wherein the neck of the deflector includes a plurality of flow notches disposed about its outer periphery, the flow notches are aligned with the channels of the deflector.

13. The irrigation nozzle of claim **11**, wherein means are provided for biasing the second helical surface into a plurality of preset positions relative to the first helical surface.

14. The irrigation nozzle of claim **13**, wherein a plurality of the depending ribs of the deflector have an outwardly-extending step at least partially along the length of the ribs such that a micro-ramp extends into the channels for directing a portion of the water flow.

15. The irrigation nozzle of claim **1**, wherein the deflector includes means for discharging more than one discrete spray.

16. The irrigation nozzle of claim **1**, in combination with a pop-up irrigation device having a riser, the nozzle configured for reducing the distance relative to a seal of the irrigation device when the riser is in a retracted position and for discharging water when the riser is in an extended position.

17. The irrigation nozzle of claim **16**, wherein the sealing pad is configured for sealing against a seal of the irrigation device when the riser is in a retracted position.

18. A method of irrigating using the spray nozzle and pop-up irrigation device of claim **17**, the method comprising:

discharging water through the at least one discharge openings when the riser is in the extended position;

forming a seal between the sealing pad of the deflector of the nozzle and the seal of the irrigation device when the riser is in the retracted position.

19. The method of claim **18**, further comprising draining fluid into the irrigation device when the riser is in the retracted position through at least one drain path.

20. The method of claim **19**, wherein the drain path is a gap in the sealing pad.

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